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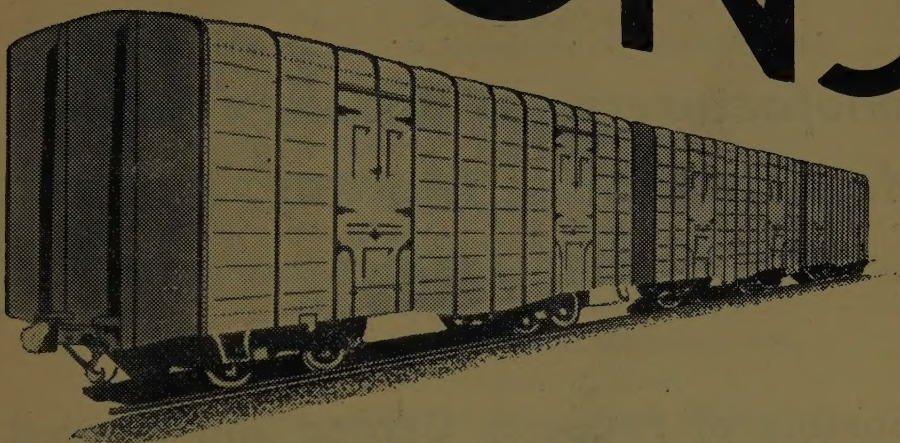

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THE EAST AFRICAN AGRICULTURAL JOURNAL

Vol. X — JULY, 1944 — No. 1

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THE EAST AFRICAN AGRICULTURAL JOURNAL

Issued under the Authority of the East African Governors' Conference and published every three months—July, October, January, April. Volume consists of four issues (commencing July issue).

FOREWORD

It is many years since chemists first attacked the problems of animal-feeding and discovered the need for protein, fats, carbohydrates and certain minerals. Their discoveries were, unfortunately, over-simplified for it was thought at the time that by the proper blending of these substances a perfect animal diet could be devised. To-day we know better. The old discoveries still hold good, for the most part, but the newer discoveries concerning the function of vitamins and some of the less common minerals in animal diet have shown that the problem is very much more complex than at first thought. The importance of mineral deficiency in East Africa pastures has long been recognized and in 1930 Sir John Orr, an eminent authority, visited Kenya to report and advise. Although much has already been discovered, a great deal still remains to be learnt, particularly in regard to the mineral content of our soils as it affects the chemical composition of herbage plants and, in turn, the nutrition of live stock. Fortunately our present state of knowledge is such as to allow us to avoid the major recognized deficiency diseases of stock. The subject is dealt with in this number by Mr. J. R. Hudson, whose article will serve as a valuable practical guide to stock-owners.

We publish in this number a symposium dealing with a curious disparity in the practice of cassava cultivation observed in the various East African territories. In Uganda, for instance, it is customary to plant long-term varieties for the most part, whereas in the other territories short-term cassavas appear to be preferred. The information provided by the departments of agriculture in Kenya, Tanganyika and Zanzibar show that both long- and short-term varieties have a definite place in native economy, depending on whether the crop is planted as a staple or merely as an alternative source of food to be drawn upon during periods of short commons, such as the one through which we are passing. Mr. Nichols, in summing up, puts forward the theory that the origin of both long- and short-term varieties is fortuitous, the former being selected, as seedlings, by native farmers in those districts where droughts and hunger-periods are of frequent occurrence, whereas in more favoured areas the short-term varieties are selected and so come into general cultivation.

Despite its well-known nutritional shortcomings, cassava, whether long- or short-term, plays a valuable role in East African native agriculture, particularly in years of drought and locusts, a fact which seems to have been overlooked by the gentlemen who met at Hot Springs* last year and reported that "cassava is a lazy man's crop" which has "been introduced far too extensively". In spite of this pronouncement, the breeding and selection of mosaic-resistant cassava varieties, both long and short-term, will continue at Amani, and, we hope, elsewhere.

With the memory of recent outbreaks of army-worm fresh in our minds Mr. Harris's article on this serious pest comes at an opportune time. The article should be of considerable practical value to farmers, for not only does it go into the life history of the army-worm but also shows the weather conditions in which an outbreak may be expected and the control measures which can be taken to combat the pest while in the nursery areas before it can do serious and widespread damage.

Until such time as plant-breeders can give us blight-proof potato varieties we must continue to expect periodic attacks of blight of varying intensity. Dr. Nattrass's article on potato blight embodies the latest available information on this disease as it occurs in Kenya. As in the case of army-worm, outbreaks of blight are largely governed by the weather, so that, at least in some countries, the attack can be predicted and appropriate control measures taken in good time. The study of the influence of weather in determining outbreaks of pests and diseases should take an important place in post-war research.

* Misc. 4 (1943) Cmd. 6461.

THE ARMY WORM

By W. Victor Harris, Entomologist, Department of Agriculture, Tanganyika Territory

Just as, in a general way, we may say that locusts are grasshoppers with a sudden inclination towards mass action, so we may regard army worms as cutworms with similar ideas. Most people who grow things in East Africa are familiar with cutworms and their depredations, for like the poor they are always with us. Army worms, on the other hand, are more irregular in appearance, more restricted in their choice of plants to attack and also more feared for the intensity of their damage. They are caterpillars which, on occasion, occur in incredible numbers over wide areas of country, and which seek out their food plants in long dense bands, moving over distances and at speeds not usually associated with caterpillars. At other times they occur singly or in such insignificant numbers that they pass unnoticed among the cutworms, the grasshoppers, and the leaf-eating beetles.

In some years army worms are numerous in one locality only, while in others the outbreaks occur over large tracts of country, often widely separated. Reports are more frequently made where European-grown maize is affected, than when only native crops, and especially grazing, are damaged. Thus it is difficult to obtain a clear picture of what has happened in the past. The season for outbreaks in Tanganyika and Kenya is from December to March. The short time occupied by an outbreak in a particular area, from a week to ten days at most, leaves little opportunity for organizing control unless preparations have been made in advance. There is some consolation, perhaps, in the fact that a second outbreak in the same season is unlikely in any one district.

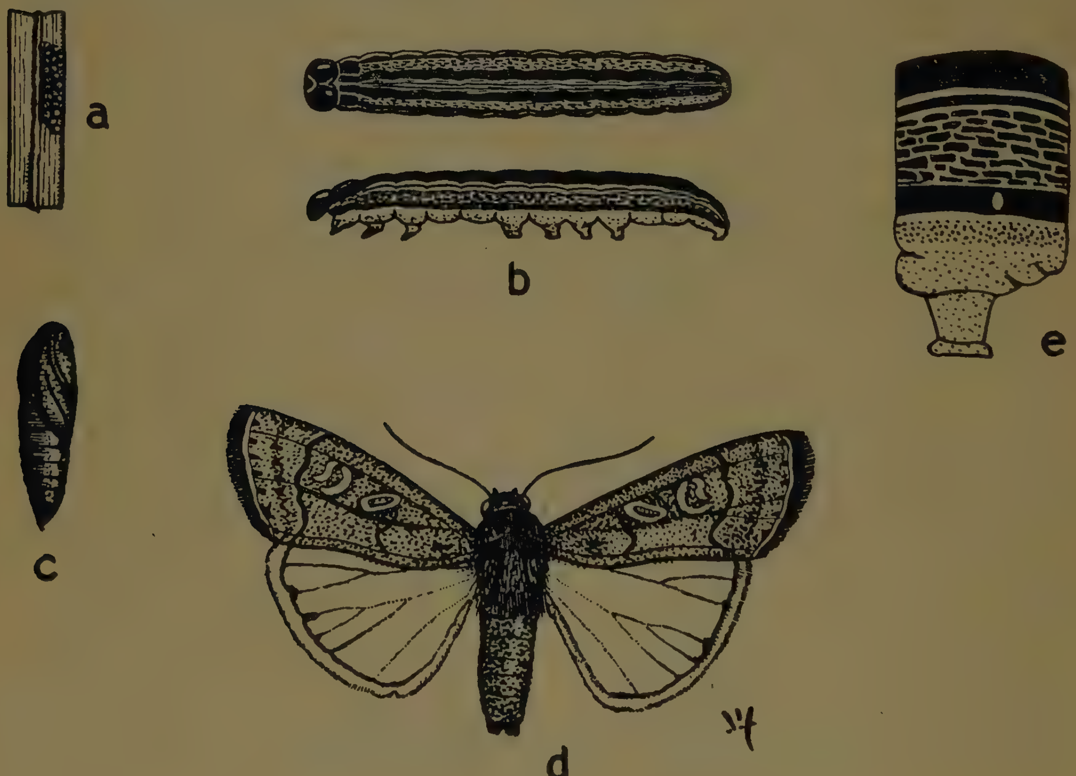

FIG. 1

The Army Worm, *Laphygma exempta*.—(*a*) Egg mass on grass, (*b*) caterpillar, (*c*) pupa, (*d*) parent moth, female; all × 2, (*e*) diagram of a body segment of an army worm to show typical pattern.

Life History

The adult insect, of which the army worm is the caterpillar, is a moth named *Laphygma exempta*, a member of the large family Noctuidae, most of whose members are dull grey or brown night-flying moths. *Laphygma exempta* is known from Africa, south of the Sahara, right across to India, Ceylon, Java, Australia and Hawaii. While apparently not of army-worm habit on the continent of Asia, where the name is applied to a related insect, it is so on the islands. In Hawaii it is known as the "nut-grass army-worm". The fall army worm of the United States is *Laphygma frugiperda*. A third species, *L. exigua*, occurs in Africa and southern Europe, and is sometimes mistaken for the true army worm, although it does not occur in such great numbers and feeds on a greater variety of food plants.

The parent moth has a wing span of 1 to 1¼ inches. The forewings are a grey-brown with distinctive spots in the female, and paler with additional markings in the male. In both sexes the hindwings are pearl-grey with a darker marginal line. The body is covered in fawn hairs.

The eggs are small, almost spherical, with fine ribbing radiating from the top centre. When newly laid they are a shining creamy-white, later turning brown as the caterpillar develops inside, and when about to hatch becoming almost black. They are usually laid in irregular masses of one, two or three layers, covered by the dull grey hairs from the female body, the number of eggs in the mass varying from half a dozen to two or three hundred. The density of egg laying varies greatly from light scatterings in young maize or sorghum free from weeds, to dense masses in tracts of succulent grasses.

The caterpillars are one-sixteenth of an inch long when they hatch out. They have dark heads and pale transparent bodies which become green after feeding. They are able to spin a fine thread with which to drop to the ground and in strong wind can be blown about like young spiders and so get scattered over a wide area. Older caterpillars have not this power. During its growth the caterpillar moults six times. After the first it is about one-eighth of an inch long and still pale-green in body colour. After the second moult, now one-fifth of an inch long, distinct longitudinal stripes appear, white on a greyish ground. After the fourth moult, the appearance is that of an army worm as generally known, three-quarters of an inch long. At the fifth moult it reaches its full length of one inch. Now only the underside of the caterpillar is green, the back has a velvety-black central stripe flanked by a paler stripe made up of broken lines on a grey-green background. The sides have a thick black line and a yellow line before the green of the belly.

The next stage is the pupa. This is formed after the fully grown caterpillar has stopped feeding, and made a small cell underground. There is no protective cocoon. The pupa is half an inch long and chestnut brown in colour.

The length of time occupied by the different stages has been worked out in detail by Hattingh (1941) and depends on the temperature. Briefly his results were as follows:—

Temperature	Egg	Caterpillar	Pupa	Moth to laying	Total
	Days	*Days*	*Days*	*Days*	*Days*
90°F.	1½	10–15	6–8	2	19–27
80°F.	2	14–16	7–10	2	25–32
70°F.	3	28–37	19–21	4	54–65

He also found that the female moths laid most eggs at temperatures between 70° and 80°. From this he concluded that "temperatures must be at least 70°F. for a few weeks before an outbreak can occur. At temperatures between 85° and 90°F. the growth of the larvae is accelerated enormously. It is not possible for this insect to remain in the pupal stage for long periods". During an outbreak at Morogoro in February, 1944, the following results were obtained:—

Eggs collected	11th February	
Caterpillars hatched out ..	12th "	
Caterpillars pupated ..	22nd "	} 10 days
Moths emerged	2nd March	} 9 days
Second generation caterpillars found	8th "	
Caterpillars pupated ..	20th "	} 12 days
Second generation moths emerged	31st "	} 11 days

Two generations thus occupied 50 days when the average daily (screen) temperature was 79°F., a mean of 25 days. From migrating army worms collected in the field the first moths emerged on the 28th February, and the last on the 1st March. No signs were found in the field of the second generation bred out in the insectary.

Behaviour

The suddenness of the onset of an outbreak of army worms is due solely to the fact that the caterpillars escape notice during the early stages of growth when they are small both in

size and appetite. The eggs are laid in dense masses by numbers of female moths in company. Usually the eggs are put on a suitable food supply for the young caterpillars, such as young star grass or grain crops not far past the seedling stage. If they have been laid on tough grasses the young caterpillars use their threads to drop down to the ground and take a chance on finding something more suitable. As the caterpillars grow, their food requirements become less exacting, but the quantity needed increases by leaps and bounds, until the slow movement from leaf to leaf during the first week develops into a strong migration away from the exhausted birth place, moving ever outwards for more and more food. Then just as suddenly the caterpillars go underground to pupate, and the outbreak is over.

The food of the army worm is almost exclusively made up of grasses, grain crops and sedges. Star grass, *Cynodon* sp. is particularly favoured by the young caterpillars. It is a widely distributed grass in Tanganyika in the areas of deciduous thicket and the Acacia woodlands, and especially as a pioneer in abandoned cultivations. In South Africa, Hattingh states that the origin of the great majority of outbreaks encountered by him could be traced to patches of *Cynodon*. The effect of the feeding together of numbers of young army worms is like scorching by fire, or burning with arsenic spray; the older army worms tend to be more completely destructive.

Natural Enemies

Most obvious of the natural enemies of the army worm are birds. Large flocks of White Storks, Abdim's Storks and Kites frequently arrive to decimate the moving bands. The White-necked Raven is also active, and though less likely to appear in such large numbers as the storks, is more generally distributed over the country.

Ants destroy many of the smaller army worms, especially in sandy land, and even the larger caterpillars do not escape. Unfortunately, the distribution of suitable ants is too irregular for them to have more than a local effect on outbreaks. The same applies to predatory wasps.

The real enemies of the army worm, however, are the parasitic insects, the Ichneumon and Chalcid wasps and the Tachinid flies. If army worms are collected and kept in cages, many will be found to go sick, flaccid and dark coloured, before pupating. Some will develop a crop of small white cocoons as they die, and from these will emerge delicate little Chalcid wasps. Others die, but a pupa can be found inside the crumpled skin, from which eventually emerges a bristly Tachinid fly. Yet again, other army worms pupate normally, but instead of a moth coming out, there appears an Ichneumon wasp.

It is believed that the numbers of the parasites often become reduced for some unknown reason, so that when external conditions are favourable the army worm multiplies to its natural limit, resulting in an outbreak. Subsequently the parasites get ahead again in the large numbers of army worms available, the population of which is then reduced again to normal levels.

Causes of Outbreaks

Local increases in the numbers of insects are known to arise from a variety of causes. For example, there is direct migration of the parent insects from an outside source, giving rise to one or more generations before the outbreak subsides. This is familiar to East Africans in the case of locusts, but it is also the habit of the fall army worm in the United States, where moths from the warm southern states migrate north as far as Canada to breed during the summer, before being killed off by the winter cold. Another cause is the alteration of climatic conditions towards the optimum for rapid and successful development, usually a rise in temperature being the important factor, as is seen in the rapid increase of maize weevils in upland areas as the weather gets warmer. As a final example, there is a disturbance of the balance between an insect and its natural enemies, which permits of the host insect getting ahead of its parasites and increasing its numbers before the inevitable reaction sets in and the parasites get the upper hand until equilibrium is restored.

Here let it be interpolated that the migrations of white and yellow butterflies, noticeable in certain seasons, have no direct relationship with army worms. That both phenomena may arise from similar climatic or other conditions is not impossible. Hudson (1943) records a prediction of army worms by a Kenya native following on a migration of butterflies (*Glycestha* spp.) in July, 1939, which was fulfilled during the following March.

The two main theories on the causes of army worm outbreaks are given in detail by Faure (1943) and Hattingh. The first favours the idea of migrations of moths over a wide area from small limited areas where conditions

normally allow the army worm to exist, and where at intervals these conditions alter favourably to a degree permitting the development of swarms. The similarity of this theory to the now well-established "phase law" in locust behaviour is heightened by the discovery by Faure of phase variation in the army worm, whose colour can be altered at will by keeping the caterpillars singly or in crowds during their growth.

Earlier, Hattingh came to the conclusion that the army worm is normally present, though reduced in numbers by adverse conditions, throughout the areas where outbreaks are liable to occur. If, however, there arrive simultaneously (*a*) high temperatures to induce maximum egg-laying and accelerated development and (*b*) delayed rains so that there is an abundance of short grass suitable for young caterpillars, then outbreaks will develop.

The climatic conditions prevailing prior to and during the 1944 outbreak in Morogoro are shown graphically in Fig. 2.

The following outbreaks have been recorded in Tanganyika in recent years, though the list is not complete:—

1925 December	Dar es Salaam.
1930 January, February, March	"Practically the entire territory."
1931 February, March ..	Eastern Province.
1932 February to April ..	Northern Province.
1937 April	Northern Province.
1940 February	Eastern Province.
1944 January	Mahenge (Eastern Province).
February	Eastern Province.
March	Lake and Northern Provinces.

CONTROL MEASURES

The most satisfactory method of dealing with an army worm infestation is to wipe it out in the early stages, while the caterpillars are concentrated in the nursery areas. This entails a watch being kept for a rising temperature with just sufficient rain to have produced a flush of young grass without rank growth, attention being paid to river banks and damp valley bottoms with patches of *Cynodon* grass, or similar fine-leaved types, and to old cultivated lands going back to bush fallow. If the caterpillars are discovered, they can be wiped out with the standard locust spray of five ounces of arsenite of soda in a

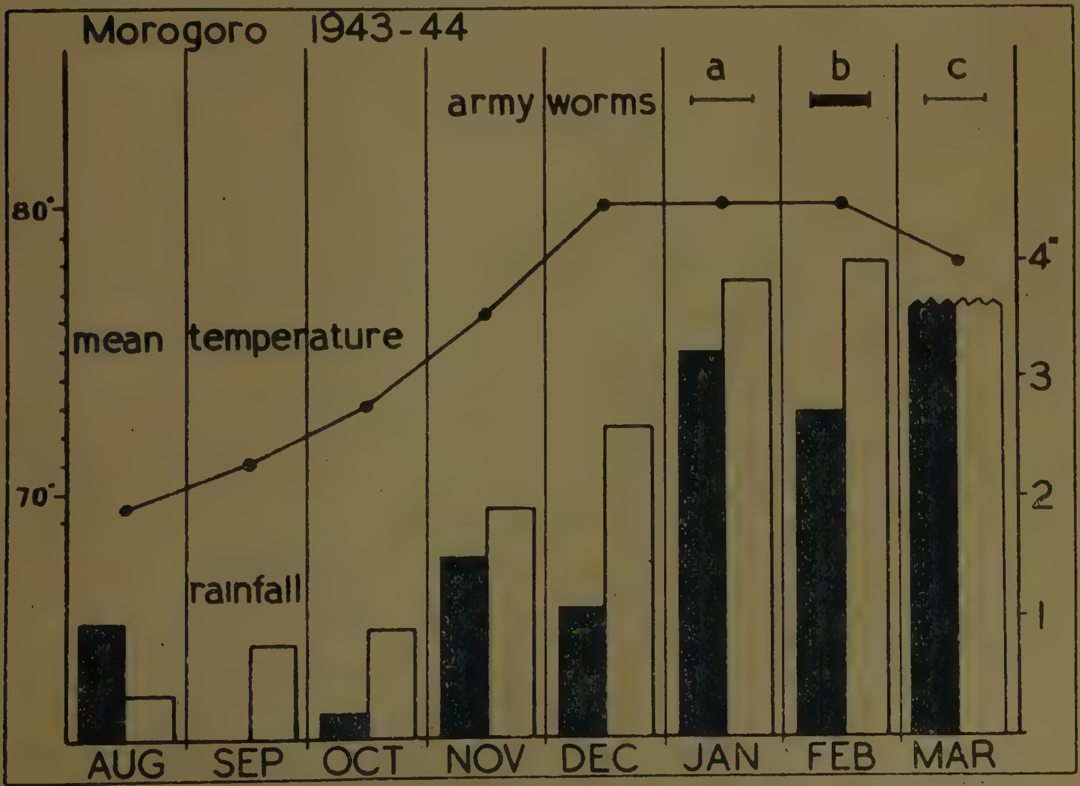

FIG. 2.—Climate of Morogoro in relation to Army Worm outbreak, 1944. Rainfall—actual in solid columns, average in open columns. Army worms—(*a*) hypothetical pre-outbreak generation, (*b*) outbreak, (*c*) post-outbreak generation in the laboratory.

four-gallon tin of water. This spray will destroy the vegetation for the time being.

Cultivated land can be protected by ploughing a furrow some 18 inches deep across the line of advance of army worms, the furrow being finished off by hand to make the sides vertical. In Rhodesia, Jack (1930) states that a Martin "Ditcher" is among the most suitable implements, while single-furrow mouldboard ploughs and even ridging ploughs were used to good effect. Once the trench has collected a good number of army worms it is well to spray with arsenite, or squash them with a log pulled along the trench bottom.

Poison baiting is not really a practical control measure. Good results are reported at times, but in general the army worms prefer the grass or cereal crops and ignore the bait. Spraying with insecticides which will not injure the crops is expensive. The writer has had some success in protecting young maize and sorghum with barium fluosilicate dust applied at the rate of 20 pounds per acre with a rotary hand-blower. Hattingh reports similar good results with cryolite, a natural fluosilicate, in South Africa. These dusts are non-poisonous to stock, at this rate of application, and can be used with safety on silage crops and grazing paddocks.

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THE FLOWERING OF DERRIS ELLIPTICA

Derris is always propagated by means of stem cuttings and very few reports of its flowering and seeding are received.

In Malaya it is said to flower if allowed to grow for five or six years to a considerable height, sixty feet or more, around the edge of the forests. Two supplies of seed have been received in Amani from Malaya but in both cases none germinated.

Some seed were recently received from an estate on the Central Line in Tanganyika: again none germinated.

Attempts have been made in Amani to induce flowering by various methods. Plants have been made to climb supports to a height of about thirty feet and after six years a few flowers were produced but none set seed.

Plants on normal supports, six to eight feet high, were exposed to the light of a 300-watt electric bulb every night for a year so as to see if increased hours of light would produce flowering. No flowers resulted.

Plants left for six years on supports six to eight feet high also produced no flowers.

Some very interesting results have, however, been obtained at Amani during a sand culture experiment designed to determine the effect of shortage of various mineral constituents. Derris elliptica plants were grown in cement barrels of sand, watered with nutrient solutions, and given supports ten feet in height. The full nutrient solution used was one-half the normal strength of Hoagland's standard, and all the others were based on this.

When only two years old plants receiving only one-tenth and one-fiftieth the normal amount of calcium, but normal amounts of all other constituents, produced a few flowers which did not, however, set seed. At 2½ years old considerable flowering occurred, about a quarter of them setting seed, with those plants having deficiencies of calcium, both alone and in conjunction with a deficiency of nitrogen and with a deficiency of potash. Plants deficient in calcium plus nitrogen plus potash, in nitrogen alone, in potash alone, in phosphorus alone and in nitrogen plus potash gave very few or no flowers. Plants receiving full nutrient solution gave an intermediate number of flowers. Pollination was by natural means and not induced artificially.

About 50 per cent of the seeds obtained germinated successfully.

One year later the same amount of flowering occurred on the same plants and many seeds have set, but are not yet ripe.

The indications therefore are that flowering is encouraged by lack of calcium, but it is possible that the roots having become somewhat "pot-bound" may also play some part in the process.

Growers should be warned not to grow derris from seed, in the unlikely event of their getting any, as this might result in a general lowering of the rotenone content of their crop. Any ripe seed obtained could be sent to Amani where it would be used in trials designed to select strains with even higher rotenone content than the present "Amani" strain.

R. R. WORSLEY.

SOIL SALINITY RELATED TO THE CLEARING OF NATURAL VEGETATION

By the late G. Milne, Soil Chemist, East African Agricultural Research Institute, Amani, and W. E. Calton, Assistant Government Analyst, Tanganyika Territory

In 1940 the late Mr. Milne visited a group of sisal estates in the low-lying country at the foot of an escarpment where encroaching soil salinity had been reported. He left a comprehensive report which is of general interest because it points to a closer relation between soil conditions of upland and ajacent lowland than is generally realized and the phenomenon may repeat itself elsewhere. The conception of a catena or topographic sequence of soils implies that each type in the series is inter-related and affects the other. Here, where the problem centres on two very mobile soil constituents—water and soluble salts—the catenary aspect is important; in fact, without appreciation of it, the appearance of toxic amounts of salt and the possibilities of encroachment or recession are largely unpredictable. The following summarizes Mr. Milne's report. The junior author was concerned with the investigation and was responsible for the analytical work.

The damaged sisal was on low ground adjacent to the flats of a river. At the time it was planted the soil conditions, as judged by the natural vegetation (grasses and herbs), were considered normal, though evidently the water-table was near the surface during the rains. At first the sisal grew satisfactorily and several cuts of good leaf were obtained, but for some time, and especially after 1939, large areas had been dying, together with all weeds and other vegetation except a salt-bush *Suaeda monoica* Forsk, (locally called "Nyonya" and well known as a dominant in saline soils) which was not there originally. In some places so much salt had been accumulated on the soil surface that it was collected by natives. The steady spread of the salt even into areas well above swamp level was noticed.

Preliminary soil samples sent to the Laboratory confirmed that a high concentration of salts, about 6 per cent, was present in the surface soils where sisal had died completely. A sample from an area of dying sisal showed 1.5 per cent salts, and an adjacent area of still healthy sisal had about 0.7 per cent at 18 in. depth, though there were only traces near the surface. The salts were chlorides and sulphates of sodium and magnesium with traces of sodium carbonate at depth in one area.

A study of the problem in the field showed that it involved the conditions of soil formation and water balance in the whole of the stretch of country, which is a narrow strip of sloping ground lying between the foot of the high escarpment and the flood plain of the river running roughly parallel to it.

TOPOGRAPHY

The escarpment marking the boundary of the plateau here runs in a N.W.–S.E. direction and a 14-mile stretch of it forms a nearly straight line of high cliffs rising to over 6,000 ft. The railway, the main road and the strip of cultivable land lying above and below these run close under the escarpment at a height of 1,400–1,500 ft. Much of the escarpment is precipitous bare rock, which is a rather schistose gneiss. There are scree accumulations below forming a moderately sloping foreland. Steeply descending short spurs divide the escarpment face and foreland into a series of bays, each of which is a small drainage basin discharging on to the plain. The catch in these basins consists only of the rain that falls on the edge and face of the escarpment, the spur ridges and the ground between them, the main drainage of the highland plateau being in the opposite direction. Of the short streams that rise on the escarpment face one is fairly considerable and has a permanent flow. The others discharge into seasonally swampy ground at the edge of the plain, are lost by absorption in the detritus they have brought down, or between rains fail altogether at their sources.

The river flows south-east, roughly parallel to the escarpment. Its course has to some extent been pushed by growing escarpment fans to the far side of the plain against outlying high ground. From these hills the Mkomazi receives little drainage, as rainfall upon them is low and the water requirements of the natural vegetation leaves little surplus to percolate underground. The river enters over a 40-mile stretch, has an average gradient about 1 in 1,000, and tends to fill beyond the capacity of the channel to carry away the flood water. Overflow occurs, suspended matter is deposited over wide areas, and finally dissolved matter also, as the floods dry off.

By this process of deposition, together with shifting of the channel across the valley over a long period of time, the valley floor has been filled with alluvium, mostly of fine-grained character, but still readily capable of further chemical decomposition. The river, though now only flooding portions of the plain, undoubtedly affects ground-water regime above flood level.

At times a great deal of storm water reaches the stream from an extensive semi-arid catchment area in the Pare–Usambara Gap. The soils there are non-leached, easily erodible types, and their erosion products largely determine the composition of the floodplain alluvium further downstream.

The Ground Water of the Plain

The water-table under parts of the plain now cut off from surface overflow from the river may still be affected by shifts of its course, scouring or aggradation of its bed, or changes in its seasonal behaviour. Thus water from the escarpment arriving at the edge of the plain but not normally flowing to the river in any open channel must either seep away through porous strata or be consumed on the spot by vegetation or by evaporation. If enough of it escapes, the water-table will be kept down, but if escape is checked, the water-table rises. As to the manner of escape, there are two general possibilities:—

(*a*) Flow down a gentle gradient not far below the ground surface, and discharge directly to the river. In this case flow will always be checked at times of high water in the river, and if the river is depositing upon its bed and so gradually raising its own level, even at low water, the water-table gradient will be progressively flattened, and water backed up at the edge of the plain.

(*b*) Flow into a sandy stratum sandwiched in the clay alluvium, or into a gravel bed representing a former river channel. From some point of the present river channel there is leakage of river water into the same sandy stratum or gravel bed. Scour of the river bed may increase the amount of this leakage, overtax the capacity of the reservoir formed by the porous beds, and so raise the water-table at a distant point.

Thus the fact that the river in its present channel is a mile or more away from some of the saline areas we have to consider, and does not now actually overflow them, by no means allows us to rule out the main river and its behaviour as factors not affecting the problem.

It should be stressed that the ability of surface water to get away, by drainage in the open across sloping ground, is not really the essence of the matter. The important thing is the shape of the dry-season water-table in relation to the surface of the ground; for it is when the free water surface comes within about two metres of the ground surface, and is maintained there for some time during dry weather, that evaporation from the soil brings up salts into the root zone and finally concentrates them in the top few centimetres. Thus if water from the escarpment seeps outwards towards the plain some distance below ground, and encounters a change of porosity in the soil bulk through which it is passing, it will come up towards the surface at that place if the supply is maintained. Such a change of porosity does occur at the outer edges of the alluvial fans, where finer material has been deposited and there is a transition to the deposits of the plain proper, consisting mostly of sediments of fine grain. We are therefore likely to find the "sump" effect manifested in some degree all along the transition line between fans and flood-plain; not by total obstruction of outflow, but by slowing down due to change of porosity. If a certain rate of supply of seepage water is not exceeded, the water can continue to get away without rising too near the surface. If for any reason at the lower end the rate of escape to the river is reduced, or if for any reason at the upper end the supply is increased above the safe limit, up comes the water-table in the transitional zone.

The Soils

The total width of the cultivable strip varies from about half to three miles and can be divided into three zones. The highest-lying zone comprises the more gently sloping terminals of the projecting spurs and the parts of the foreland covered by bouldery debris and hillfoot colluvium. The middle zone consists of fans of alluvial material which have been built up in the past by the escarpment streams and have joined and overlapped to form a continuous alluvial apron. The lowest parts of the strip lie on the floodplain of the river.

The soils of the upper zone are shallow coarsely gritty loams, grey-brown or dull chocolate at the surface, brown to reddish-

brown below, passing into brashy weathered rock at 2 ft. depth or less. There are many outcrops and boulders. Natural vegetation appears to have been mainly open bush with dense grass growth. Temperatures are fairly high and equable, though rainfall is variable, ranging in ten years from 21 in. in the driest year to 58 in. in the wettest, and is markedly seasonal, nearly half the total usually falling in April and May. Topographic position keeps these soils "juvenile"; as they develop in depth by weathering they are thinned off the surface by wash. Under natural conditions surface wash is held in check, they are not leached to exhaustion and remain fertile.

The soils of the middle zone are deeper and more mature. They are sandy loams of dull chocolate colour, moderately humic and crumbly at the surface. Below the surface they are reddish-brown to dull orange-brown, somewhat heavier and with little change to a depth of 6 ft. They are neutral to slightly alkaline in the top 8 in., have a slightly acid reaction in the next 16 in., and trend towards neutral at greater depth. Free carbonate and soluble salts are absent from the top 6 ft. and the water-table is deep. Though of a maturer stage of formation than the soils of the belt above, they still have a fair reserve of unweathered or part-weathered minerals. In a 10 years' record rainfall varied from 17 in. in the driest to 49 in. in the wettest year with the same seasonal distribution as in the belt above. No original vegetation is to be seen.

The soils of the outer edges of the alluvial fans, marginal to the flood-plain, are of finer texture and darker colour lying on gentle slopes. As far as can be judged the original features of this zone are dark chocolate-brown silty clay topsoil with a cloddy subsoil which swells on wetting and becomes almost impermeable. Reaction is slightly acid at the surface, becoming slightly alkaline at depth. Below 16 in. the texture remains the same, but the swelling on wetting becomes more pronounced and calcium carbonate appears, at first slight in amount and locally distributed, increasing in abundance until at 7 ft. the material is a clayey marl. Gypsum occurs from 2 ft. downwards. Considerable amounts of soluble salts are now found in the middle subsoil of this type. It is fairly certain that this degree of salinity is not an original feature, but has been induced by rise of water-table.

The lowest lying soils of the sequence are heavy black cracking clays, used as grazing land or swamp types used in places for rice. They were not examined in detail.

The Saline Areas

The areas where surface salinity has recently developed occur patchily and form a rough line parallel to, and about midway between, the escarpment and the river. One saline area occurs at a point where a major escarpment fan stretches out across the main valley and leads to local sump conditions. At another it is not so clear that drainage is being held up by differences in land level, though slight differences would be enough. The change of texture from coarse escarpment-fan alluvium to finer grained flood-plain alluvium and consequent slowing up of drainage may be of significance. Analytical data on test pits (see Table I) show a fundamental downward trend in the development of all types—for example, increasing clay and calcium carbonate with depth, which is evidence of past through-drainage. No exchangeable base data are available, but it appears probable that a fair proportion of these in the clay complex of the three lower soils may, under natural undisturbed conditions, be sodium. It can be inferred from the topography of the region, the relative freshness of the parent material and the semi-arid climate that groundwaters would naturally be saline. At the lowest site sampled, the high concentration of salts depresses the hydrolysis of the sodium clay—as shown by the absence of sodium carbonate—and keeps it in a friable condition. This explains the lower water-table at this point. It does not follow that the water-table should be horizontal—in fact it will always have a definite shape depending on surface configuration, porosity, etc., and will never reach final equilibrium. The large amount of surface salt is explained by the raising of saline waters by capillarity followed by evaporation. The wick-like action of capillarity can operate over a distance of 6 ft. or more.

At the other end of the sequence the soil under healthy sisal is a straightforward through-leached type with no soluble salts or even carbonate. The three intermediate profiles have higher clay contents than the two extremes and show progressively the interplay of rising saline groundwater and falling rain or superficial water. In profile IV groundwater has risen to 24 in. and much has been drawn up and evaporated at the surface. The advancing groundwater appears to consolidate its gains by making subsoil clay more impervious.

This could be done by ascending sodium entering the subsoil clay complex which would deflocculate and become slimy as a sufficient protective concentration of salt shifted to the surface. The more or less deflocculated clay layer would subsequently be more permeable to saline than to fresh water. Profile III probably illustrates this; the downward current, temporarily more powerful, has distributed the salts evenly over the three upper layers, but has been abruptly checked in the fourth layer. Profile I shows increasing salt content from the bottom of the pit to about the 16 in. level, where it was on balance at the time of sampling held by the downward current or the limit of capillary action.

The test pits sunk in the saline areas show essentially the same soil conditions.

Control of Water and Salt Balance by Vegetation

The factor which seems of greatest significance in the recent development of surface salinity is the clearing of natural vegetation. This has been extensive in the past few years and has now reached a stage at which the effects of the disturbance of a naturally nicely balanced set of conditions can be seen. After their arrival in the rain as "cyclic salt" or their liberation from the local rocks or rock debris by the weathering process, soluble salts are distributed according to the fate of the soil moisture in which they are dissolved. Before the escarpment foot was extensively cleared the roots of trees and shrubs and of dense grass growth intercepted much of the percolating water during the rainy season. In many places in the subsoil, salts which had gone down a certain distance would not be washed away because soil moisture had been reduced by "transpiration draft" to less than that at which flow can take place. The effect of the deep-rooted natural vegetation covering the hill-foot strip was thus (*a*) to limit the amount of water that reached the plain, (*b*) to cause the retention of a proportion of the season's yield of soluble salts in the deep subsoil. On the other hand, when the natural bush has been cleared and replaced by a crop, more water is likely to get by during the rainy season, and seepage will continue longer into the dry season. During the first few years after clearing, salts that were immobilized in the deep subsoil will be flushed out, and added to the stocks held in the saline ground-waters of the plain. There may be a significant addition, also, from the soluble constituents of the ash of the burned bush. The total effect of clearing, if extensive, will be to overtax the discharge capacity of the subsoil of the sluggishly drained areas on the plain, and at the same time to increase the salt content of the ground waters. A progressive rise of water-table ensues, and the hitherto fertile soils are salinized.

There may be other causes of the rise of the water-table due to complex effects of the behaviour of the river on the ground-waters of its flood-plain. These questions are difficult of exact investigation and lie rather in the province of the hydrographic engineer and geologist, but we suggest that the effect of clearing on the moisture balance of the escarpment-foot soils is of itself a sufficient explanation.

Remedial Measures

The foregoing analysis of the nature and causes of the trouble seems to show that unless the margins of the plain can be effectively drained, the whole breadth of the escarpment-foot strip cannot be kept in full utilization, at least under field crops, at any one time. Either the lowest areas must be abandoned or the highest areas re-forested. Extensive re-vegetation with trees can hardly be considered a practical proposition. If the engineering side of the drainage problem can be solved, there is nothing in the nature of the soils that should prevent their responding to a few years of improved drainage. They belong to a group of alkali soils much studied in other parts of the world under the name of *solontchaks* and to the calcareous division of this group. On leaching they first of all lose the greater part of their excess salts and run together into a sticky impervious condition due to the nature of the sodium clay of which they partly consist. At this stage it is of the utmost importance to establish some sort of vegetative cover, whatever will tolerate the conditions, to open it up and dry it out from below. During the next season or two, chemical reactions take place between the sodium clay and the calcium carbonate that are present in the subsoil. Sodium is turned out from combination with the clay and calcium takes its place, with an improvement in physical properties. The sodium carbonate formed is washed out in succeeding rainy seasons until the soil is restored to normal. The success of the process depends on the presence of abundant calcium carbonate or gypsum. The analyses show that calcium carbonate is already present in these soils. Gypsum is available locally and would

be useful as top-dressing. The soils promise high fertility when freed from salts.

The question then turns on the practicability of drainage as an engineering problem: on the cost of this in relation to the value of the produce of the reclaimed land: and on any reactions that the effects of drainage might have on other lands on the plain. Effective drainage, which discharges the water and its dissolved salts into a main flowing waterway, can hardly be other than beneficial to the whole area. To transfer the water merely to another sump further out on the plain would be injurious to lands adjacent thereto and might also fail to achieve its immediate object. For the groundwater conditions of all parts of the flood-plain are likely to be inter-dependent.

In conclusion, though the investigations dealt only with the problem as seen on certain estates, it seems probable that salinity will occur at other places where the topography and other relevant circumstances are similar. The problem is, in fact, likely to be a regional one.

Summary and Conclusions

An area of low-lying country where sisal has been destroyed by the recent development of surface soil salinity has been examined.

A concentration of about 1.5 per cent soluble salts in the surface soil appears to be lethal to sisal.

The development of surface salinity is related to a rising water-table which in turn is related to a disturbance of drainage conditions following extensive clearing of natural vegetation.

Remedial measures are outlined and it is suggested that if these measures are practicable there is nothing in the nature of the soils to prevent their being reclaimed and becoming highly fertile.

TABLE I

ANALYTICAL DATA ON TEST PITS

I.—Healthy Sisal

(Chocolate sandy loam)

Depth	Soluble salts	pH	Clay content	$CaCO_3$
	Per cent			
0–3″	Nil	7·8	18	Nil
3–8″	"	7·0	—	"
8–16″	"	5·8	25	"
16–24″	"	6·0	—	"
24–32″	"	6·4	—	"
32–40″	"	6·4	21	"
40–48″	"	—	—	"
48–56″	"	6·6	—	"

Pit quite dry.

II.—Limit Healthy Sisal

(Dark chocolate-brown clay)

Depth	Soluble salts	pH	Clay content	$CaCO_3$
	Per cent			
0–3″	0·06	6·4	55	Nil
3–8″	0·3	7·6	—	Trace
8–16″	1·35	8·6	61	7
16–24″	1·45	8·9	—	—
24–32″	1·2	9·0	—	—
32–40″	0·9	9·2	68	18
40–48″	—	9·3	—	—
48–56″	0·9	9·4	—	—

Pit wet and greasy at bottom but no standing water.

III.—Dying Sisal

(Dark greyish-chocolate clay)

Depth	Soluble salts	pH	Clay content	$CaCO_3$
	Per cent			
0–3″	1·5	7·5	44	Trace
3–8″	1·5	8·1	—	—
8–16″	1·5	8·5	60	18
16–24″	0·8	9·0	—	—

Standing water at 24″

IV.—Dead Sisal

(Dark greyish-chocolate clay)

Depth	Soluble salts	pH	Clay content	$CaCO_3$
	Per cent			
0–3″	2·6	8·5	—	Present
3–8″	0·9	8·9	—	"
8–16″	0·75	8·9	—	"
16–24″	0·7	9·2	66	14

Standing water at 24″

V.—Bare Saline Patch

(Dark greyish-chocolate clay)

Depth	Soluble salts	pH	Clay content	$CaCO_3$
	Per cent			
0–3″	6·8	7·6	—	—
3–8″	3·5	8·0	41	Trace
8–16″	2·1	7·9	—	—
16–24″	1·6	8·0	48	2·5
24–32″	1·55	8·1	—	—
32–40″	1·6	8·1	52	4
40–48″	1·9	8·0	—	—
48–56″	2·0	7·9	—	—

Standing water at 56″

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SOME RECENT OBSERVATIONS ON THE PLANTAIN CROP IN BUGANDA

By G. B. Masefield, M.A., A.I.C.T.A., Agricultural Officer, Uganda

INTRODUCTORY

The present paper does not pretend to give a comprehensive account of the cultivation of plantains* in Buganda. This may be found in literature already published, which however is perhaps worth listing for those who wish to refer to it. A good general outline of the subject, though rather short, is given in "Agriculture in Uganda" (by the staff of the Agricultural Department, publ. Oxford 1940), Section IV; this is particularly notable for the full treatment of the banana weevil menace by Mr. Hargreaves. In "The Baganda", Roscoe gives a useful account of plaintain cultivation from the point of view of the anthropologist, though his terminology is not always such as to appeal to the technical agriculturist. An article by A. D. Forsyth Thompson in the *Uganda Journal* Vol. II (1934) deals with "The Uses of the Banana"; one by the present writer in the *East African Agricultural Journal* Vol. III (1938) on "The Production of Native Beer in Uganda" deals with plantains from that aspect. Much useful information will be found scattered in "A Report on Nineteen Surveys done in Small Agricultural Areas in Uganda, etc.", published by the Government Printer, Entebbe, in 1938. The "Vocabulaire Luganda—Français" of Father Le Veux gives interesting references to the many special terms used by the Baganda in connexion with plantains, under the articles "olusuku" and "ekitoke", and also a list of 42 varieties.

The purpose of the present article is not to recapitulate any of these publications, but to embody some personal observations on the crop with a number of notes recorded by others in recent years, most of which are unpublished and all of which are scattered and seem to be worth bringing together. These will now be considered under the separate heads under which they arise.

ACREAGES CULTIVATED

Our knowledge of the relative acreages of plantains cultivated in different parts of Buganda has been much increased by the long series of *mitala* surveys carried out between 1935 and 1940. These are the same as the "Surveys in Small Agricultural Areas" referred to above, but only a small proportion of the surveys carried out in Buganda are amongst those published. The following table gives acreages of plantains from 14 *mitala* in Buganda:—

Mutala	County	Average acreage per holding	Average acreage per taxpayer
Kyanamukaka..	Buddu.. ..	2·02	2·11
Kawoko ..	"	2·20	3·00
Kayuji	"	1·44	1·61
Kabale	"	1·58	1·95
Kitambuza ..	"	1·72	1·96
Kalongo ..	"	2·47	2·60
Musansala ..	"	1·43	2·15
Kiyimbwe ..	"	2·86	3·93
Luzinga.. ..	"	2·52	3·09
Average of Buddu County ..		2·03	2·49
Nansana ..	Kyadondo ..	1·25	1·33
Lwada	" ..	0·69	0·75
Average of Kyadondo County ..		0·97	1·04
Lubogo	Butambala ..	2·49	3·05
Kyabalogo ..	Kyagwe ..	1·53	1·96
Bukeka ..	Bulemezi ..	2·40	2·40
Average of all Mitala		1·90	2·28

The most striking feature which emerges from this table is the difference between the average of 2.03 acres per holding for the rural county of Buddu—which may be taken as the ideal which the Muganda will aim at where he has enough land and the normal amount of labour—and the average of less than half this amount in the urbanized county of Kyadondo, where land is short and the able-bodied men are largely employed in wage-earning work.

MAIN TYPES OF PLANTAINS

Three main tyes are cultivated in Buganda, "matoke nkago" for boiling (or rather steaming), "mbidde" for beer-making, and "gonja" for roasting or beer-making. (The preference

* To most readers the name "plantain" will not be so familiar as "banana" and the distinction will not be clear. It must be confessed that it presents difficulties. Macmillan (*Tropical Planting and Gardening*) writes: "In the West Indies the term *plantain* is applied only to sorts eaten cooked, being generally distinguished from the banana by their larger and horn-shaped fruits . . . In the Eastern Tropics, however, their distinction is not generally recognized, both 'cooking' and 'table' sorts being commonly known as plantains". He might have added that in East Africa most Europeans call all the *musa* fruits bananas.—Ed.

varies in different counties, e.g. in Buddu and Sese they are mainly used for eating, in Mawokota and Busiro for beer.)

One example of the percentage of different types grown is given in "Agriculture in Uganda"; since then similar counts have been carried out in three *mitala* surveys in Masaka District, giving an average of 74 per cent "Matoke nkago" to 26 per cent "mbidde".

Further counts were added during 1941, when investigations were made by the Medical Department into the breeding-places around Entebbe township of the mosquito *Aedes simpsoni*, a vector of yellow fever. The total number of plantains counted to obtain percentage of types was 87,445; those examined for *Aedes* breeding were 1,648. These investigations produced the interesting conclusion that water retained in the leaf-bases of the "gonja" plantain breeds *A. simpsoni* far more often than is the case with the other plantains. This is illustrated by the following table:—

Type of plantains	Percentage of all plantains	Percentage holding water	Percentage breeding *A. simpsoni*
	Per cent	*Per cent*	*Per cent*
Gonja ..	1·6	85	25
Matoke ..	—	30	—
Mbidde ..	94·4	19	—
Sweet ..	4·0	58	2

Sweet bananas, mostly of the small variety producing "lady's fingers" and known in Luganda as "menvu", have for long constituted a small percentage of the crop in areas near townships, chiefly for sale to non-natives. In recent years, however, a semi-sweet variety known as "Kisubi" (from the supposed place of its first introduction or distribution) has come increasingly into favour for beer-making in the "home counties" area round Kampala, and bids fair to oust the "mbidde" for this purpose. Both the tree and fruit are very like those of the ordinary "menvu"; the fruit, however, is distinguished by being more rounded, with the lines on the corners less marked. I am told that when left to ripen, Kisubi bananas taste very much like "lady's fingers" but tend to be hard at the core. This, however, is difficult to test as they are never normally allowed to ripen, but are used in the green state for beer-making. Under pressure of war-time export demands, however, Kisubi have been exported green to Kenya as sweet bananas, having turned yellow by the time they arrive, and appear to have been found acceptable.

The proportion of the different types planted varies in different areas. For example, in Mubende District the proportion of "mbidde" is high. In the Sese Islands, the people plant a very high proportion of "gonja" and prefer this to "matoke nkago" as a food. In Butambala, a county largely inhabited by Moslems whose tenets forbid beer-drinking, the proportion of beer bananas is low.

The types also have special characteristics which may affect their prevalence in particular places. For example, Kisubi are said to yield better than other kinds on poor exhausted soils such as occur round Kampala, and this may largely explain their popularity in this area, though the large market for beer bananas round Mengo and Kampala is no doubt also one cause for it. Beer made from Kisubi is stronger than from "gonja", which in turn is stronger than from "mbidde". "Gonja" plantains have with some Baganda the reputation of being less easily uprooted in gales than other kinds, and are therefore sometimes particularly planted in exposed situations and at the edge of the plantain garden. Both "gonja" and Kisubi are believed to have a harmful effect on trees of "matoke nkago" adjacent to them, and for this reason both kinds are usually planted in groups and at the edge of the garden rather than interspersed among the "matoke" as the "mbidde" are. The Baganda believe that "gonja" attract lightning, and consequently do not plant them near their houses. "Mbidde" are the only type normally used for slicing and drying as a famine reserve food (known as "mutere" in Luganda), but I am told by a Muganda who has tried it that palatable "mutere" can also be produced from Kisubi.

I have spent much time in trying to learn from Baganda a method of distinguishing "matoke nkago" from "mbidde" by their appearance. It seems, however, that there is no constant diagnostic feature other than the taste of the fruit; and that their capacity to distinguish between the two depends on their knowledge of the varieties of each which are grown in their own locality. Questions as to how to distinguish the two types invariably produce replies which are applicable to local varieties only. For example, in Buddu I have been told that "mbidde" may be distinguished by the very narrow leaves of the young suckers; this is a feature of *Nsowe*, the commonest variey of "mbidde" grown there, but not of all varieties. In Bulemezi, I have been told that "mbidde" have a red edge to the

petiole, and "matoke nkago" a black one; this is true of *Kabula*, the commonest local "mbidde" and of common local varieties of "matoke nkago", but is not universal. I have only been able to discover one clue, and that not visual, which seems, so far as I have tried it out, to be of general application. This is to bite into the pulpy part of the petiole near the base of the lamina; in the "mbidde" varieties the taste of the juice is somewhat sour, in "matoke nkago" it is sweeter.

An empirical test which is often useful for recognizing these two types is that in most parts of Buganda the women cut the flower head off its stem as soon as the bunch is formed in the case of "matoke nkago", but leave it on for "mbidde". Even this, however, is not universal as there are some localities in Buganda, e.g. parts of Bulemezi, where the flower head is not cut off for the former kind.

Varieties of Plantains

Within each main type there are many varieties. The longest published list is that compiled by Nye ("Report on Nineteen Surveys", p. 99) from Bukeka *mutala*, in which he lists 59 varieties of "matoke nkago", 13 of "mbidde", and six of "gonja". The study of plantain varieties has been somewhat neglected in the past owing to the fact that many of the varietal names are synonymous, used to describe the same plantain in different regions. This fact has, however, I think, been over-emphasized and certainly does not create so much confusion with plantains as with sweet potatoes, for which crop varietal names change frequently not only with place but with time as well. The standard varieties are known by the same name nearly all over Buganda (excepting those areas where special dialects are spoken, e.g. Lunyoro, Lukoki, Lusese, etc.). The largest living collection of varieties is at Kawanda Experiment Station, where 31 varieties of "matoke nkago" are being grown.

It seems to be of interest to record some observations on the distribution and characteristics of some of the more important varieties, though I cannot attempt to go into their diagnostic features; this being a matter which still awaits the prolonged and minute attention of a botanist.

Of the "matoke nkago" varieties, the two commonest by far throughout Buganda are *Nakitembe* and *Nakabululu*, and these two between them probably constitute well over half the crop. *Namwezi* is a variety particularly typical of Busiro county, and in that area is perhaps the commonest variety. *Mbwazirume* is typical of eastern Kyagwe, and takes its name from the "mbwa" fly of that region, but is also common in many other parts. *Nsakala* is common in Buddu, *Sira* in Bulemezi, and *Malaya* round Entebbe. Other varieties which are fairly common in many areas are: *Kafunze*, *Lwewunzika*, *Kibuzi*, *Muvubo*, *Nabusa*. The numerous remaining varieties of "matoke nkago" are not common, and comprise only a very small fraction of the crop.

The two common varieties, *Nakitembe* and *Nakabululu* are very similar in general appearance, both having more or less blackish "stems". The Baganda distinguish *Nakitembe* by its longer fruits, by the flower parts being very persistent on the end of the banana, and by the leaves being more or less in two rows on the stem. The following remarks on individual varieties are offered with some scepticism, as cultivators' opinions vary widely. *Nakitembe* and *Nakabululu* are said to be very long-lived, which may account for their great popularity. *Nakabululu* and *Nakabinyi* were said by one man in Bulemezi to be the heaviest yielders, but the latter not to keep it up for so long. Another statement records that *Sira*, *Mbwazirume* and *Kibuzi* are the heaviest yielders; in the case of *Sira* this impression may be merely due to the fact that the individual bunches are very big (*Nsakala* and *Muvubo* also have big long bunches). *Nakabululu* and *Mbwazirume* were mentioned in different places as doing particularly well on poor soils.

Amongst "mbidde" varieties, Kabula is by far the commonest throughout most of Mengo District, with *Nsowe* second. In Masaka District the position is reversed, with *Nsowe* first and *Kabula* second, and this also applies to a small area in Mawokota county bordering on Masaka District. A third variety, *Mende*, is fairly common in Bulemezi and adjoining areas. In Mubende District, the most common variety of "mbidde" is one with the Lunyoro name of *Nyamaizi*. All other varieties of "mbidde" are much less common than these.

Of "gonja", the commonest variety everywhere is probably *Majaga*, with *Nakatansese* second.

Banana Weevil

Since the account of this pest in "Agriculture in Uganda" was written, its distribution has undoubtedly increased very widely. I have either seen it or heard it reported from the majority of counties in Buganda, and it may

be doubted if there is now a single county which is free from it. This cardinal fact in the history of the crop has passed with little comment.

Baganda will maintain that some varieties are more resistant to this pest than others. I have heard *Namwezi* and *Nakabululu* mentioned as being resistant, and *Nsowe* as particularly susceptible. The Senior Entomologist, however, states (in letters) that what little evidence is available does not give any indication of difference in resistance between varieties. In a survey at Kawanda, 27 varieties of plantains growing locally were all found to be infected by the weevil. On the other hand differences in soil fertility and the general health of the plant are known to affect greatly the severity of attack. Sweet bananas, both Kisubi and "menvu", are also stated to suffer less from the pest than plantains do, but this subject has not yet been investigated.

Plantains as Food

Chemical analyses of *Nakitembe* and *Nakabululu*, and of "gonja" plantains (variety unnamed) made in the laboratories of the Agricultural Department, Uganda, were published in the Annual Report, Part II, for the year ended 30th June, 1937, pp. 54–56. Some interesting figures, including analyses of varieties from Bukoba very similar to those of Buganda, are given by Raymond and Jojo ("The Nutritive Value of Some Tanganyika Foods—1. The Banana" in this *Journal*, Vol. VI., p. 105, 1940). According to the first of these, the proportion of food to total weight of the bunch is about 50 per cent, i.e. the rest is skins and stem.

The average size of bunch in Buganda varies greatly. On the poor exhausted soils around Kampala, a common weight is 20 to 30 lb. On fertile soils in Bugerere, bunches average between 50 and 60 lb. Of the average kind of bunch sold in Buganda markets, it is generally reckoned that a man needs a third to a half of a bunch (according to size) as a day's ration. In rationing labour, a figure frequently used is that where plantains are the main starchy food, a man's daily ration should be about 8 lb of the peeled material.

Some suggestive figures were obtained by the Agricultural Officer at Masaka, when carrying out *mitala* surveys, in response to a suggestion from the District Medical Officer. Samples were collected from (*a*) young plantain gardens on fertile soil, (*b*) old plantain gardens on worn-out soil, and these "matoke" were sent in for analysis. From these the following results were obtained:—

	Percentage moisture	Percentage crude protein
	Per cent	*Per cent*
New plots (average of three samples)	72·60	3·98
Old plots (average of three samples)	75·30	3·38

From these figures it may further be deduced, from the difference in total dry matter, that the percentage of carbohydrate as well as of protein must be considerably higher (probably some 2 per cent difference) in the new plots than in the old plots. This is a very remarkable result, that both protein and carbohydrate percentages should be notably higher in the new plots. It is borne out by similar samples of cassava and sweet potatoes collected at the same time from fertile and from worn-out plots, and merits further investigation.

Notes on Cultivation

In a recent paper by Brown ("Native Agricultural Implements in the Uganda Protectorate", this *Journal*, Vol. VIII, p. 96, 1942) the subject of implements used in cultivating plantains has been incidentally treated. I should like to add one point on the implement described and figured by him as "ekiwalizo", but more commonly known in Buganda (where, however, it is not a common implement) as "ekiwabyo". This consists of a semicircular blade on the end of a long handle, and the beauty of it is that the central part of the blade is sharpened both on its upper and its lower edges, so that plantain leaves at varying heights can be severed by either an upward or a downward stroke. This makes it a very handy tool for its purpose.

In some of the *mitala* surveys in Masaka District, inquiries were made to ascertain as nearly as possible the age of the different plantain gardens. These produced the following interesting figures:—

Mutala	Age in Years		
	Average	Oldest	Youngest
Musansala	16	45	1
Kalongo	19	40	1½
Luzinga	18	40	3
Kiyimbwe	21	60	3
Kitambuze ..	12	32	2

Little is known of the average yield of trash (dead "stems" and leaves) from plantains per acre per annum. A figure obtained from banana plantations in New South Wales puts it at 11 tons. So far as I am aware, the only record in Uganda is one kept for some years recently for the trash from a single stool in Bugishu, which is hardly enough to go on, but indicates a figure of about the same amount.

This trash is of immense importance in Buganda as it is used for mulching the crop, and is the main safeguard against both soil erosion and soil exhaustion. That it has special virtues is evinced by an experiment some years ago at Lyamungu which showed that the yield of coffee was more increased by a mulch of plantain trash than by a mulch of grass. Of recent years, the importance of laying the mulch in strips across the slope has been stressed in Buganda as an additional safeguard against erosion in cases where there is not enough mulch to cover the whole surface. Elephant grass is also often cut and used as a mulch for the plantain crop. A danger in this, often seen in the plantain gardens of careless cultivators, is that in wet weather the grass roots at the nodes and soon tends to form a growing mat which has to be laboriously weeded out. To guard against this, the elephant grass should only be carried during the dry season when there is little danger of its sprouting, or else the bundles of grass should be stacked after cutting until they are too dry to sprout, and only then spread as a mulch.

A traditional method of preventing erosion in plantain gardens, still often practised, is the digging of silt-pits ("ebitaba" in Luganda). This is in my opinion definitely a dangerous method which is not to be encouraged. My reason for this is that so often these silt-pits are dug too shallow, or not cleared out when partially silted up, with the result that the retaining bank is either overflowed at its lowest point or broken at its weakest. The outcome is the sudden release at one point of a great volume of water, and in this way neglected silt-pits often act as funnels initiating gully erosion worse than anything they have prevented. Mulching is a safer way of preventing erosion, and probably involves less labour. No doubt, however, silt-pits are to be preferred to doing nothing at all to check erosion.

In recent times plantain gardens have departed considerably from their traditional conception in Buganda. Bark-cloth trees (*Ficus natalensis*), which were formerly interspersed through every plantain garden, are now much more rarely planted, and it is possible that this loss of a valuable wind-break has been a considerable disadvantage to the plantains. As the coffee crop has increased, coffee trees have been interplanted in numerous plantain gardens. However desirable this may be for the coffee trees, it tends to kill out the plantains and to reduce the amount of mulch available per square foot of area, so that the soil cannot be kept in as good a condition as before. Many plantain gardens in the "home counties" suffer from this in an exaggerated form by being so interplanted with coffee, fruit trees, "Cape lilac", cassava, etc., that the plantains are few and far between and it becomes impossible to aim at mulching the whole surface.

The deteriorated condition of plantain gardens in the "home counties" of Buganda generally is one of the most urgent agricultural problems of the area. So little do the plantains in this area bear that some Baganda near Kampala frankly plant them for the sake of the leaves only (these having a very wide use for eating off, for wrapping food to be steamed, and for other purposes). The population of this area are largely becoming sweet-potato eaters instead of regular plantain eaters, as the former crop is considered to do much better on the poor exhausted soils. In this area the erosion danger is being met by a campaign for gully-stopping and increased mulching, and where there is not enough mulch available and erosion is already serious, bunding and the planting of stop-wash lines of elephant and vetiver grass are also encouraged.

The soil-exhaustion problem is much more difficult. Trials on the application of dung and cotton-seed to plantains are in progress at Kawanda. Observations on the regeneration of plantain gardens by uprooting strips across the slope and planting elephant grass for a fallow period are being made at Kawanda, Nsangi, and in the environs of Kampala. Exact experiments on the yield of plantains have, however, always proved very difficult owing to the fact that this crop when grown by public institutions is considered fair game for stealing. For the same reason it has been found an unsatisfactory crop, whatever its dietetic value, to be grown by prison farms, hospitals, etc.

ECONOMICS

There is a very large traffic in both eating and beer bananas to supply the larger townships, especially Kampala. The plantains are brought in by bicycle and lorry from distances of up to 50 miles, and even more in times of scarcity. Many growers in the distant areas allow themselves to be cheated by middlemen who buy from them at very low prices and then re-sell at a ridiculously high margin of profit in Kampala. Some of the worst of these sharks are bicyclists who buy up plantains in the villages and merely take them to the main road for sale to a lorry owner, often earning an enormous profit for a service which it is hardly necessary to perform at all.

The seasons of greatest abundance are in June–July and in December; the greatest scarcity usually occurs in April and May. Little fluctuation in prices occurred in pre-war years. For example, in Masaka market from 1937 to 1939 it is recorded that the price of plantains remained steady at 50 to 60 cents per bunch. Round Kampala, where selling by weight has been slowly gaining in favour, the price before the war had settled to about 2 cents per lb. (weighed as whole bunch). At the present time, prices are controlled under the Defence Regulations. In contrast to these prices in the townships, prices in remote country areas are very low. In 1942, a bunch could be bought for 20–30 cents in many areas over 50 miles from Kampala.

The cost of maintaining a plantain garden is indicated by the following figures obtained from a model smallholding at Bukalasa Experiment Station in about the year 1935:—

	Sh.	cts.
Cost of planting per acre, at 12 ft. × 12 ft. ..	10	00
Upkeep per acre per annum in early years ..	19	26
Upkeep per acre per annum, in later years ..	30	00

The income obtained from the sale of plantains by cultivators over large areas of Buganda exceeds that from cotton, especially in years when cotton prices are low and the acreage not at its largest. A rough estimate of the agricultural income of the average cultivator in Mengo District, made by an Assistant District Commissioner and an Agricultural Officer, in 1942 (before the demand for new wartime export crops had altered the balance of an economy which had existed for some years) was as follows:—

From sale of:—	Sh.
Plantains	100
Cotton	70
Coffee	50
Various crops (beans, groundnuts, simsim, maize, potatoes, etc.)	20
Miscellaneous produce (hides, skins, milk, eggs, poultry, bark-cloths, etc.) ..	10
TOTAL *Sh.*	250

ACKNOWLEDGMENTS

Grateful acknowledgment is made to the Provincial Agricultural Officer, Kampala, for permission to quote material from files in his office. The majority of the *mitala* surveys in Masaka District, to which frequent reference has been made, were carried out by Mr. D. F. Stewart, Agricultural Officer.

SACKING POULTRY HOUSES

Sacking makes serviceable walls for poultry houses. Old grain bags are cut open along the seams and nailed tightly on to the outside framework, with clout nails, and the joints neatly sewn together. When complete, the sacking is thoroughly soaked with water and the following mixture applied with a brush, giving one coat on the inside and two or more on the outside.

Mixture.—Water, 1¼ gallons; cement, 12 lb.; lime, 2 lb.; salt, 1 lb.; alum, ½ lb. Sieve the lime and salt to break up lumps, add the water then the cement, stirring while adding, and the alum last. Select a dry, cloudy day for the application of the mixture. The second and subsequent coats must be applied when the former is wind-dry. It is known that such houses have given good service for a number of years. This material is also satisfactory when used on pitched roofs.

E. F. Lombard in *Farming in South Africa*

CORRECTIONS

Vol. 9, part 4 (April, 1944)—

Page 188, 1st col., 9 lines from bottom. For *Acacia laliae* read *Acacia lahai.*

Page 192, Table 1 and footnote; p. 193, line 21 and Table 2. For *Cynodon plectostachyon* read *Cynodon plectostachyum.*

Page 192, Table 1. For *Cynodon transvallensis* read *Cynodon transvaalensis.*

Page 236, 2nd col., line 22. For *Dodonea* read *Dodonaea.*

Page 250, 2nd col., line 28. For *Mysopsis* read *Maesopsis.*

POTATO BLIGHT*

By R. M. Nattrass, B.Sc. Agric. (Lond.), Ph.D. (Lond.), D.I.C.,
Senior Plant Pathologist, Kenya

The disease of potatoes known as "Blight" (*Phytophthora infestans*) has been present in East Africa since 1941, and must now be considered as an endemic disease likely to break out with greater or lesser intensity wherever the crop is grown. Blight belongs to the class of fungi commonly described as the "water moulds". In contrast to many other parasitic fungi which thrive under dry conditions, these have retained many of the characteristics of an aquatic environment. The reproductive bodies, sporangia and swarm spores, are produced during periods of high humidity and a film of moisture is necessary for their germination. It is easy to see, therefore, that the initiation of, and severity of, an epidemic outbreak are, to a very great extent, determined by the weather.

Much attention has been given in different countries to a study of the weather conditions preceding outbreaks of Blight. It is now possible in these countries to foretell from meteorological observations when an attack is likely to occur, and spray warnings are then broadcast. In the West of England, for instance, the two conditions considered necessary for an outbreak to occur are a minimum temperature of 50°F. and a relative humidity of not less than 75 per cent for at least two days. Similar determinations can be based on other favourable factors, such as a combination of dew at night, a minimum temperature of 50°F., under five hours' sunshine, at least 0.01 inches of rain and a relative humidity of not under 75 per cent at 3 p.m. In Holland, the criteria are dew for at least four hours during the night, a minimum temperature of 50°F., a mean cloudiness next day of 0.8 or above, and at least 0.1 millimetre of rain during the next 24 hours.

It will be seen that during these favourable periods the humidity during part of the time is at or near saturation. These conditions will also provide for a film of moisture on the foliage to ensure germination of the fungus spores. In North America, the essential conditions for a rapid spread are said to be a relative humidity of 95 per cent for eight hours, which permits formation of sporangia, and this humidity must persist, with actual liquid water at the right temperature, for infection of foliage to take place. It is stated that in Palestine the disease does not occur when the temperature rises above 78°F. Although all authorities are agreed that the minimum required temperature is about 50°F., there is little information available about the upper limit. In Kenya, with a daily variation of 20°F. or more, conditions may be favourable at night and activity of the fungus slowed down during the day. It is, however, doubtful if, given requisite humidity, a temperature as high as 78°F. does inhibit development of the fungus in Kenya.

The origin of the outbreaks of Blight has been a matter of a good deal of speculation. It is now generally agreed that, at any rate in countries where all green foliage is destroyed in the winter, a fresh outbreak starts from an infected tuber planted with healthy seed or from a heap of diseased potato refuse. Early observation of an attack in the field generally points to one or more foci from which the disease spreads. These slightly infected seed tubers are not easy to distinguish. They are not sufficiently diseased to prevent sprouting and so they produce a sprout above ground which is already permeated by the mycelium of the fungus. As soon as the weather is favourable, spores are produced which infect the plants in the immediate vicinity. There is plenty of evidence that refuse heaps, or "cull piles", as they call them in America, may also become the focus of an attack but, in an enlightened farming community, refuse heaps of potentially dangerous material are not left where they can do harm. In the Highlands of Kenya, there is probably no season when somewhere or other potato plants are not growing. Even in the dry seasons, up to near the forest line diseased plants may be found in native *shambas*. Moreover, many small tubers which may be infected survive long drought periods underground and may, when the rains come, produce infected sprouts. It is also known that the Blight fungus can live as a saprophyte on decaying vegetable matter in the soil round a blighted tuber and that this mycelium may also produce spores. At any rate, it does seem that in a country like Kenya,

* For an illustrated account of the fungus and of the symptoms of Blight, *see* Nattrass, R. M., 1942. Potato Blight, this Journal, 7, (4), 196.

with its varied climate and lack of hard winter conditions, the Blight will always survive from one crop to the next.

It is the practice in all countries where Blight is of regular occurrence to spray or dust the crop with a copper fungicide. Dusts are less effective than sprays, but are useful in years of mild attack only. Although it cannot be said that spraying will completely prevent Blight, the experience of years has proved that the correct fungicide applied at the right time will, even in a bad Blight year, reduce crop loss to negligible proportions.

The first essential to successful control is to put on the spray before the disease has taken hold. Spraying is preventive; the object is to protect the foliage so that the alighting spores are killed on coming into contact with the fungicide. Once the fungus has penetrated and is developing inside the plant, the fungicide cannot destroy it. It is recommended, therefore, that the first spraying should be done soon after the plants are established and when they are 6 to 8 inches above ground. By this time, should there be any foci of infection in the crop, they will not have had time to develop and the crop will be protected from wind-borne spores from adjacent crops. Further applications should be made at intervals of from ten days to three weeks. The object is to keep the newly-developing foliage adequately protected. This may be considered to be the ideal schedule and is indicated when conditions are generally favourable to the fungus. As a general rule, the number of applications is limited to three.

It is not to be expected that the full schedule will always be necessary. The conditions outlined above may not develop until later in the season. Spraying can then safely be left until the weather changes. The critical application is the one put on just before the attack materializes. To leave it until this happens is, of course, taking a chance and everything must be in readiness to spray at a moment's notice.

It can only be safely adopted when sufficient equipment is available to cover the whole crop in a short time. When this is possible, spraying has been found to be effective when not more than two or three spots are on each plant. If deferred for as little as two days after this, it is too late to have any effect. The safest plan is to put on the first spray, whatever the conditions are, at an early stage and then wait until a further application is indicated. Any appearance of Blight in the district, in native *shambas* or on volunteer plants in the vicinity, must be taken as the signal to spray. Unless general infection of a field results from wind-borne spores from nearby crops, the foci of attack occur in isolated spots. These are easily missed but, should they be observed before the disease has spread to the surrounding plants, the foliage of the infected and nearby plants should be destroyed or sprayed at once. The immediate application of spray to these areas by a man with a knapsack sprayer may delay the onset of a general attack and enable the crop to be covered in time.

The application of the spray will depend on the apparatus available. There is no doubt that a fine misty spray at a high pressure is the most economical method as there is little waste by dripping and a good cover is obtained. It is, of course, best to spray when the weather is fine, but if there is continuous rain, it is better to put on the fungicide rather than wait for two or three days as, during this time, infection may have taken place. Spraying should not be done during heavy rain. Once the spray deposit has dried however, it will not wash off readily and traces will persist throughout the growth of the crop. If heavy rain falls before the spray has had time to dry, much will wash off and the operation will have to be repeated. For the treatment of small plots in gardens, experiments have shown that sprinkling of the fungicide with a watering can gives good control. The complete cover formerly advocated does not appear to be absolutely necessary and it is probable that, when the leaf is wet, sufficient copper will diffuse into the film from scattered deposits to prevent spore germination.

For small plots, the bucket pump with a 15-foot hose will be found admirable. The correct spraying nozzle is, however, now difficult to obtain. Recently a number of A.R.P. stirrup pumps have been made available. These are equipped with a nozzle throwing a jet of liquid. At a distance of about four yards this jet breaks up into droplets. By keeping this distance away from the plants and moving the jet over the crop a good "watering can" effect can be obtained. These pumps are worth a trial.

Tuber infection takes places when spores produced on the foliage get washed down through the soil. The nearer the tubers are to the surface of the soil, the more likely are they to become infected. Earthing up, therefore, affords considerable protection. Tubers may also become infected when they are

lifted during wet weather if the foliage is still fresh and the fungus actively producing spores. Potatoes dug while the tops are still growing are more likely to become infected as not only is the skin not set but it is, consequently, more liable to be bruised or damaged. Tubers should be left in the ground for at least two weeks after the haulms have died or after they have been cut. In some countries, it is the practice to kill off the haulms and, at the same time, destroy the Blight by spraying with sulphuric acid or copper sulphate solution. Unless for immediate use, potatoes should never be dug while the haulms are still green if the disease is present.

Destroying the haulm is especially important with "earlies" or when potatoes are being produced particularly for seed. For the best seed, the potatoes are dug when they have reached seed size. As soon as this stage is reached, it is advisable to cut the haulm and to leave the tubers for two weeks so that the skin will become set.

The standard home-made mixtures for control of Blight contain 1 per cent of copper sulphate neutralized with lime or soda to make Bordeaux or Burgundy mixture respectively. Stronger solutions up to 2 per cent can be used and may be an advantage in certain localities or during very wet seasons, but there is little difference in the fungicidal value of the two strengths. The following formulæ for 1 per cent strength are recommended; for 2 per cent, double the quantities given will be required:—

BORDEAUX MIXTURE:

1. Copper sulphate ..	4 lb.	5 oz.
Quicklime ..	4 lb.	5 oz.
Water	40 gallons	3 gallons
2. Copper sulphate ..	4 lb.	5 oz.
Hydrated lime ..	5 lb.	6½ oz.
Water	40 gallons	3 gallons

BURGUNDY MIXTURE:

3. Copper sulphate ..	4 lb.	5 oz.
Washing soda crystals ..	5 lb.	6½ oz.
Water	40 gallons	3 gallons
4. Copper sulphate ..	4 lb.	5 oz.
Magadi soda ash ..	2½ lb.	3 oz.
Water	40 gallons	3 gallons

The choice of the fungicide will depend on the materials available. Where good quicklime or good dehydrated lime is not readily obtainable, Burgundy mixture made with washing soda crystals or Magadi soda ash (household soda) is recommended. Some difficulty may be experienced at the present time with regard to suitable vessels. Copper sulphate and the Burgundy mixture will corrode iron or galvanized metal and, therefore, cannot be used either in the preparation or for the final product. A coating of bitumen will, however, make a steel drum or a petrol tin suitable for the purpose. To make the spray, dilute solutions of the two components are mixed together. The copper sulphate can be dissolved in the bulk of the water in a wooden barrel or bitumen-coated drum and a concentrated solution of the soda made up in a bucket or other small vessel. This is then added slowly to the copper sulphate solution, the whole being well stirred. It makes little difference whether solutions of equal bulk are mixed or whether the copper sulphate or the soda form the concentrated solution, but two concentrated solutions must not be mixed and the mixture afterwards diluted.

Thus, to make, say, 40 gallons of mixture with Magadi soda, this quantity of water is put into the barrel or drum. A bucketful is removed into which is dissolved the 2½ lb. of soda. The 4 lb. of copper sulphate are then added to the remainder of the water. If powdered, it will quickly dissolve in so large a bulk, but it is important to see that both are completely dissolved before proceeding further. All that remains to be done now is to slowly pour the bucketful of soda solution into the barrel of copper sulphate solution, keeping the mixture well stirred during the process. The same procedure can be adopted when making up small quantities for garden use. In this instance, a cup or jug can replace the bucket, and a bitumen-covered kerosene tin the barrel or drum.

If the quantities are accurately weighed and the copper sulphate and soda reasonably pure, a safe spray will result. It can be tested, if required, by dipping into the solution a piece of blue litmus paper. If this turns red, the mixture is too acid and more soda solution must be added until a fresh piece of paper remains blue. It should be noted with the Magadi soda ash spray, the one most likely to be used in Kenya, there may be a certain amount of scorching of the terminals. This is more likely to occur when the plants are sprayed in hot sunshine and with the stronger 2 per cent mixture.

Bordeaux mixture can be made with hydrated lime in the same way. A bucketful of the water is removed from the measured bulk and the lime added to it. The copper sulphate is dissolved in the remainder of the water in the barrel and the cream of lime slowly run into it.

The making of Bordeaux mixture with quicklime is rather more troublesome. It is important that the quicklime should be of good quality and freshly burnt or have been kept in an airtight container. Lime, a portion of which has absorbed carbon dioxide from the air, is useless.

If quicklime is to be used it must be carefully slaked. This is done by putting the requisite amount into a bucket or other vessel and sprinkling with just sufficient water to make it crumble to a powder. When this action is over, more water is added to make a cream and finally, a milky liquid. The exact procedure will depend on the available vessels. If only one wooden barrel can be obtained, it should be used to make the dilute copper sulphate solution, the lime being prepared in a galvanized bucket or kerosene tin. The milk of lime should be strained through a fine sieve or piece of sacking into the copper sulphate solution. Properly made, Bordeaux mixture will not corrode an iron vessel, so that if no large wooden barrels are available, the lime can be made up in the bulk of the water less a sufficient quantity to dissolve the copper sulphate. This concentrated copper sulphate solution must not be prepared in a metal vessel unless the surface is well protected by enamel, paint or bitumen. The bitumen-coated kerosene tin referred to above does very well for this.

If spraying on a large scale is to be done, the use of stock solutions at a strength of, say, 1 lb. of either ingredient to the gallon makes for quick working, especially with quicklime Bordeaux. To make 40 gallons, 32 gallons of water are run into the tank. Four gallons of stock lime are added, followed by the slow stirring in of four gallons of copper sulphate solution. Stock solutions will keep for a long time if protected from evaporation. This can be made in the same way with washing soda crystals or Magadi soda. Once the solutions are mixed, however, the spray should be used as soon as possible, at any rate within 24 hours, as the physical properties of the flocculent precipitate rapidly deteriorate. The Bordeaux mixture can be tested with litmus paper in the same way as Burgundy mixture. Two other tests, which will not work with Burgundy mixture, are (1) a piece of bright iron, nail or knife blade, will after a minute or so become coated with a deposit of copper if free copper sulphate is present. If this happens, more lime solution must be added. (2) a piece of potassium ferrocyanide paper (made by soaking white blotting paper in a dilute solution of potassium ferrocyanide and drying) when dipped in the mixture should not change colour. If more lime is needed, the paper will turn pink or brown.

The amount of spray needed to cover an acre is about 120 gallons, rather less for the earlier and more for the later applications. For three sprayings at 1 per cent strength, 36 lb. of copper sulphate and either 36 lb. of quicklime, 45 lb. of hydrated lime, 45 lb. of washing soda crystals or 22 lb. of Magadi soda ash will be required.

There are various proprietary copper fungicides on the market which can be used instead of home mixed Bordeaux or Burgundy mixture. The best known of these are Peronox, Coppesan, Oxycop and Buisol. They need no preparation other than addition to the requisite amount of water. The makers' recommendations as to strength should be adopted.

(*Received for publication on 23rd March*, 1944)

RECOMMENDATIONS FOR SEED STORAGE

(1) For seeds exposed to a temperature of 80°F. for more than a few days the relative humidity of air should be no higher than 45 per cent.

(2) For seeds exposed to 70°F. the relative humidity of air should be no higher than 60 per cent.

(3) Very short-lived seeds, such as onion and shelled peanut, old seed, or seed contaminated by fungi should be kept at a lower humidity than is recommended above.

(4) For seeds in cold storage at 50°F., the relative humidity of air should be no higher than 70 per cent, and preferably should not be above 50 per cent.

(5) Seeds removed from cold storage at a humidity above 50 per cent should be dried to a moisture content safe for the temperature of later exposure, unless they are to be planted within a few days.

U.S. Department of Agriculture Leaflet No. 220.

AGRICULTURE IN THE MATENGO HIGHLANDS

By A. S. Stenhouse, Senior Agricultural Officer, Tanganyika Territory

In travelling from Songea towards Lake Nyasa, one passes through the Matengo country, a small highland area which is a continuation of the Livingstone Mountains. It is a pleasant land of bubbling streams, varying in altitude between 4,000 and 7,000 feet. The hills are steep and the valleys narrow. There are no trees, except for small patches of surviving rainforest on the higher mountains. The traveller cannot help noticing that even the steepest hill slopes are cultivated. These hillside cultivations are of very striking appearance, showing an orderly lay-out, with straight-cut edges, and the surface of the fields is curiously pitted. The impression gathers force that this cannot be native cultivation. But it is. It is the Matengo Pit System of cultivation. What is the tribe who practise this peculiar system? Under what circumstances did the system evolve? What are its objects?

The Wamatengo are a small tribe inhabiting the highlands between the Ungoni Plateau and Lake Nyasa in the Songea District. At one time they occupied broader lands, but the arrival of the raiding Wangoni (of Zulu-Swazi origin) and the slave raiders drove them into the mountains where they now reside.

Constant raiding by the Wangoni drove them further and further into the hills, and restricted their settlements to the neighbourhood of large natural caves which could be defended, or to the most inaccessible mountain tops.

The problem of survival in such steep country, and in such restricted areas must have been acute; but the Wamatengo proved equal to it. Not only did they evolve a system which gave them a degree of immunity from the most destructive raids, but they also evolved a system of agriculture, including crop rotation, systematic fallowing, and soil conservation measures, which enabled them to keep their restricted lands under constant cultivation, and to preserve their precious soil against erosion even on the steepest hillsides.

The Wangoni raided the Matengo country for foodstuffs and women. (There were no cattle.) The women were protected in the caves and on the less accessible mountain tops. They were often made unattractive by mutilation. Foodstuffs were made readily available to the raiders in the most accessible and fertile valley-bottoms. So long as these valley-bottom supplies lasted, the less accessible hillside cultivations were left alone. Thus the Matengo peasant cultivated about twice as much land as needed. Half of his crop he expected to lose to the raiders, and the other half he hoped to retain for his own use. To this day he cultivates in the most energetic manner about twice as much land as he needs, and disposes of the surplus. This paying of a food tribute to the Wangoni may have been imposed on the Wamatengo. On the other hand it may have been evolved by the Wamatengo for their own protection.

The drain upon the scanty soil resources available to the Wamatengo must have been severe. They had to feed themselves and at the same time supply a satisfactory amount of food for the raiders. The problems of how to maintain fertility, and how to prevent erosion on the steeply sloping land available had to be tackled. The system evolved to meet these problems is probably unique, and will be best understood if a description is given of how the work is undertaken.

When breaking land from grassland or fallow, the Wamatengo men cut the grass and lay it in rows forming a grid. One set of rows roughly follows the contour, and the other set is at right-angles to the first set. The rows are 7 to 10 feet apart, depending on the amount of grass to be covered, and on the depth of fertile soil with which to cover it. When this work is viewed from a distance the crossing rows of grass with the squares of soil in between give a "chessboard" effect. Cultivation is done by the women. (The men used to stand guard.) Each village works communally with accompanying beer drinks, but each field is individually owned. The soil in the squares is dug out and pulled on top of the rows of grass. The cultivator works round each square in turn. Thus one quarter of the work has to be done while facing downhill and dragging the soil upwards. Half of the work is done while standing sideways to the hill. This prevents denudation of hilltops. Digging continues until the subsoil is exposed in the centre of each square. When this work has been completed, the surface of the field is pitted where the squares had been, with beds of soil between the pits underlaid by a layer of grass compost. The pits are 4 to 5 feet across and so are the soil beds. Up to a square yard of

subsoil is exposed in the bottom of each pit. Storm drains are not made if a hillside is cultivated by this method right up to the top, but where the hilltop cannot be cultivated, a storm drain is usually made above the highest cultivated field.

The women do the planting on the raised soil beds surrounding the pits. Maize is planted in short lines which tend to be radial from the pits. The lines are about one yard apart and with single seeds spaced at about one foot in the lines. The maize is nearly always planted as a pure crop. On a second field similarly cultivated, beans and peas are planted as pure crops at a spacing of 4 to 6 inches in each direction. This gives a very dense stand of these crops.

Clean weeding is the rule. Weeds are pulled out and thrown into the pits where they form a valuable compost with accumulating silt. At the end of the season, crop residues are also deposited in the pits, the old soil beds are split and the new beds formed over the old pits. The new pits occupy the place where the old beds intersected.

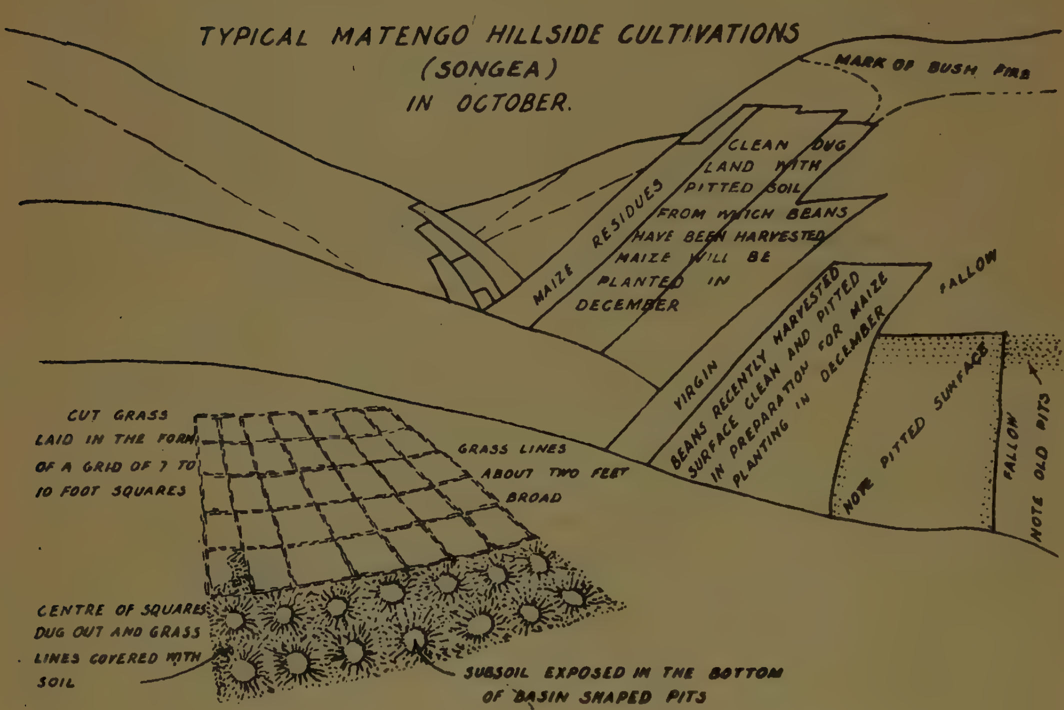
The rotation adopted is the simple one of alternating a grain crop (maize) with a leguminous crop (beans and peas). This alternation is absolutely regular and is carried on until the soil requires to be fallowed. The fallowed fields simply revert to natural grasses. The pits of the old cultivations remain and continue to function as an effective check to erosion on the fallowed land. The fallowing is systematic but not regular, because it depends on the relative fertility of the other fields at the disposal of the cultivator. Careful cultivators keep their land under cultivation for eight to ten years before fallowing is necessary.

The rotation of crops, the fallowing, and the returning of all weeds and crop residues to the soil form good agricultural practice which calls for no special comment. The pit system of cultivation (really a system of "box ridging") is so effective as a check to erosion that its functioning will bear examination. The technique is simple and almost fool-proof. No instruments are required; only a billhook with which to cut the grass, and an ordinary hoe with which to do the digging. Hillsides, so steep that it is impossible to ascend without using one's hands, are under cultivation and there is no erosion. No dangerous accumulation of water is possible, as any overflow from one pit is trapped by the next. Even heavy downpours are fully trapped and the water gradually sinks into the subsoil, so that even the smaller streams starting high on the hills do not dry up in the dry season. Footpaths and roads do not suffer from washaways, and—greatest benefit of all—shifting cultivation is unknown to the older generation of Wamatengo. Fertility has been retained and built up. The exposure of the subsoil, and the accumulation of humus is gradually deepening the layer of fertile soil, and so the Wamatengo evolved a system of agriculture adapted to their particular circumstances. The tribe survived, so the system must have been effective. Is the Matengo Pit System of cultivation the answer to some of the ills of erosion from which Africa suffers? There seems little doubt that it could be of wide and beneficial application, whether on steep hillsides or on gentle slopes. Some crops do not grow well on the beds of soil with the grass or compost below them. Examples are cassava and groundnuts; but with due caution in adapting the system to any local needs, it should prove beneficial almost everywhere.

The technique outlined above seems to be of recent origin. On some of the Matengo hill slopes, large tree roots testify to the existence of extensive forests in the not too distant past. Such hill slopes are badly eroded and bear no trace of the pit cultivations. Did the Wamatengo cultivate these slopes? The first defensive position occupied by the tribe is near the caves at Langiro, and the surrounding country there is badly eroded, even although it is now cultivated by the pit system. The second defensive position occupied is at Litembo, where every available scrap of land has been under cultivation by the pit system for a considerable period (certainly sixty years), and there are no signs of deterioration. These facts tend to show that the system was evolved in recent times, and that the dominating cause was lack of land for cultivation. Now that there is no shortage of land, the younger generation of Wamatengo are moving outwards from the old settlements and adopting lazier methods of cultivation. They are losing their grip on a valuable heritage. The introduction of cash crops is accelerating this deplorable breakdown, because they are exclusively the affair of the men. The women stick to the old system of producing the traditional food crops.

To end these notes, it may be as well to recall parallel cases, where pressure of circumstances forced the evolution of special

types of agriculture. The natives of Ukara Island, in Lake Victoria, evolved their system of mixed farming, stall feeding of cattle, and the use of manure and compost on their fields, in order to meet the pressure of population on a section of land which could not be extended and which had to be kept under cultivation. There must be other cases of this kind. Must there be severe pressure of circumstances, e.g. of population, of land, of economics, etc., before such desirable systems can evolve? The success or failure of many peasant settlement schemes will depend on the answer to that question.



ROTATION

(1) Virgin or fallow land prepared in the dry season, or residues of beans and peas dug in during September or October in preparation for planting maize with the first rains in November-December.

(2) Maize residues of previous crop cut and thrown into the old pits. Sometimes burned and then buried in February-March. Beans and peas planted in March-April.

(3) In the second year the maize crop follows on the land which carried the previous pulse crop, and the pulse crop where the maize had been.

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AGRICULTURAL POLICY IN TRINIDAD

By V. Liversage, Agricultural Economist, Department of Agriculture, Kenya

A lengthy and detailed report* on agricultural policy in Trinidad and Tobago has recently been submitted by a committee under the chairmanship of Mr. A. J. Wakefield, C.M.G. This report will be of special interest to the imaginative (and pessimistic?) reader in East Africa who may see in the conditions of Trinidad a preview of future Africa. Reading between the lines one sees a picture of a society without the cohesion of tribalism, with a bastard European civilization, an exchange economy, a scale of values expressed exclusively in terms of money and a system of education which, so far as it functions at all, is unrelated to the problems of practical living and produces frustration and discontent. Agriculture is commercialized and one-crop specialization is common. The industry is consequently at the mercy of a fluctuating market and has insufficient internal resources to fall back upon in times of stress. There is the familiar story of unsaleable surpluses side by side with unemployment and reduced purchasing power. Man cannot live by sugar and cocoa alone. Crop raising without live stock husbandry results in depletion of soil fertility and erosion. The land system is similarly commercialized, with the usual twin accompaniments of ownership-speculation-indebtedness and tenancy-insecurity-exploitive farming. Malnutrition is present. To these rural problems are added urbanization and proletarianization, which produce an outlook unfavourable to getting the best out of a peasant existence and provoke unfavourable comparisons between money incomes in rural and urban employment.

The problems are all too familiar. Unless we take active steps to avoid them they will almost certainly face us in Africa in the future. The committee approach the subject on broad lines. They recommend a shift of emphasis from the commercial aspect of agriculture to the internal economy of peasant farming, more attention to home subsistence, home handicrafts and the cultural values of rural life. Peasant agriculture should be looked upon more as a way of life and less as a mere means of obtaining a money income, but at the same time greater diversity of crop and live stock products, better utilization of local materials in dwellings and farm buildings and development of home handicrafts should lower the cash cost of a decent and secure living. Better provision of light, water, educational and medical facilities are necessary to increase the attractions of rural life and stem the drift to the towns. Agriculture must be made to absorb more workers. Peasant farming need not mean a return to a primitive level of living. At the same time peasant and large-scale agriculture alike should be planned to provide the urban areas with the food they need.

It is necessary to raise the standard of technical efficiency in production, processing and marketing. The Committee discuss the need for protecting the land against soil erosion, improving water supplies, conserving forest resources and forest cover in catchment areas, preventing bush fires, combating malnutrition by greater diversity of crops and incorporating animal husbandry in the farming system. Social welfare organizations are recommended to help the peasant to get the best out of country life.

Tenancy arrangements should be put on a sound footing by making obligatory covenants for security and compensation for unexhausted improvements in tenancy agreements. Some means of curbing land speculation should be found. Hopelessly over-mortgaged land should be taken over by the State and leased on 25-year or at most 99-year leases. The State should take powers to deal with cases of misuse of land, if necessary by expropriation. Land settlement schemes should be continued. Co-operative marketing and credit should be encouraged, but close supervision should be maintained over the operations of societies. Organized marketing should be given careful consideration.

On the subject of land settlement schemes, the Committee are emphatic that no good will come of schemes set up merely to relieve unemployment or appease popular clamour. Schemes must be set up on suitable land and must be carefully thought out. Provision should be made for holdings of various sizes, so that an "agricultural ladder" will offer energetic individuals a chance to rise in the scale, but the most successful holdings in the present stage are likely to be part-time holdings. Wherever possible the settlers should be

* Report of the Agricultural Policy Committee of Trinidad and Tobago. Part I, 1943. Govt. Printer, Trinidad and Tobago.

organized into co-operative units, so that they may derive some of the advantage of large-scale operation and be better placed to provide community services. The settlements should be carefully and continuously supervised.

In connexion with marketing, reference is made to the control of processing plants with the threefold object of preventing unnecessary multiplication of plants, controlling prices in the interests of producers, and promoting efficiency. It is argued that the costs of over-investment and inefficiency will fall back on the producer in the end. Here the reviewer would venture a comment. The theory is logical as far as it goes, but it does not take into account all the facts in the case. We have had a lot of this kind of control in East Africa, with the result, it is submitted, that any increase in final value of the produce due to improved quality has been more than swallowed up in increased processing margins, leaving the grower not better but worse off. If this policy is to be applied over a wider part of the colonial field it would be as well to arrange for a preliminary study of past results by a competent authority, competent, that is to say, in economic and statistical analysis, and to consider whether authorities can be set up whose knowledge of economics and business is more adequate to the task of price-fixing.

One recommendation which concerns plantation agriculture is of interest. It is noted that the housing provided on estates is often primitive, but that labour is intermittent and therefore the industry could not itself provide housing of an adequate standard for all. The Committee reject the "tied cottage" system, believing that the workers should have freedom to select their own employment and at the same time a secure tenure of their homes. So long as State assistance is given to urban housing it should also be provided for rural areas. This could be done by establishing village settlements under public authority in the plantation areas, each cottage being provided with land sufficient for a part-time holding or at least a garden allotment.

On the subject of research, the general policy recommended means devising new systems of farming and persuading the inhabitants to adopt new consumption habits. The available knowledge is insufficient to form a basis of new systems for the various areas. Long-term fundamental and applied research on a West Indian basis is recommended. Short-term applied research to adapt local practice to the findings of long-range research should be undertaken by the Colony. The Committee sound a note heard all too seldom in Colonial circles as to the need for the inclusion of the social sciences in research schemes. The results of research should be presented to the public in a way which they can easily understand.

The Committee rightly recognize that education is the very foundation of all reform. Their proposals involve a radical change in outlook and ways of living. They have performed a useful service in adding weight to the view so often expressed but so little acted upon, that a system of education modelled on the usual school examinations is ill adapted, if not actually deleterious, to communities of small peasants. The recommendations of the Educational Adviser to the Comptroller of Development and Welfare in the West Indies are endorsed, to the effect that while the first essential is literacy, so that the minds and wills of the people can be reached, adolescents should receive education on lines that lead to better living in a rural environment and this should be continued into adult life; moreover, the curriculum should include practical husbandry, housecraft and handicrafts. The Committee add some remarks on the training of teachers, which it is recognized is the crux of the whole matter from a practical point of view.

It is not so much the addition of a certain amount of practical instruction that is required, as a complete re-orientation of methods in accordance with some such term as "the commonsense of everyday life". Little is likely to result from practical instruction as a sideline to a literary education; the classroom education must be built up around, and take its illustrations from, the facts of rural life, biological, technical and sociological. "Classroom work is given reality and meaning to the children by its bent towards agricultural interests and pursuits." The point might have received even greater emphasis in view of the fatal tendency for a "rural basis" to peter away in a tidy little, useless little, school garden and carpentry shop. The family holding or, better still, the village community should form the model demonstration, rather than the back garden and workshop.

On the subject of getting modern knowledge home to the peasant, the Committee view the Press as the most important instrument, though this should be supplemented by simple practical demonstrations, the radio and motion-picture strips wherever possible. The ordinary Press should be used to a greater extent, and

the Agricultural Journal reconstituted on modern lines, with good illustrations. Their recommendations in this regard will strike an echoing note in East Africa. Here, as in the West Indies, the Journal serves the needs of large-scale agriculture and scientific officers rather than of small peasants, and there is no provision for sustained propaganda through a medium such as the newspaper *Baraza*. Mention is made also of the need for text-books on agriculture written with special application to local circumstances, a lack which, again, is felt also in East Africa. Altogether, if we in East Africa hope to extract the full benefit from the rehabilitation schemes under consideration for post-war development we shall have to do a great deal more to "sell" modern methods to the African.

Whether, with all the education, propaganda and improvement of conditions in rural areas, it will be possible to induce much of a return to "the simple life" is an open question. No doubt much can be done to improve the farming systems, but a move in the direction of greater self-sufficiency is a different matter. The trend everywhere has been towards specialization in farming, not necessarily one-crop farming but reduction in the number of sidelines and miscellaneous activities. Home handicrafts and processing have everywhere tended to decrease. The backyard pig has become rarer in England. The African woman who formerly extracted dyes from wild plants now prefers to buy them in a packet from the local store. The simple life is a misnomer. It is much simpler to confine productive activities to one or a few lines and secure purchasing power, which can then be allocated in any proportion to any desired items of consumption. Home subsistence is analogous to barter. The advantages of specialization seem to outweigh the disadvantage that much of the value of the produce sold is absorbed in and the cost of goods purchased swollen by the cost of marketing and distribution.

The Committee have proposed a considerable number of schemes involving public expenditure, direct or indirect. Direct expenditure includes research, advisory and educational services, credit, housing schemes, afforestation, water supplies, light and power, and subsidization of industries. Indirect burdens on the community are involved in the proposal to place protective tariffs on certain classes of imports, to guarantee minimum prices and to compel collective sale through one channel where two-thirds of the producers of a particular commodity express a demand for it. Consumption is to be raised both quantitatively and qualitatively. All these measures are concerned with the enjoyment of real income. Now it is all very well to insist on a higher real income, but means have to be found for providing this income, a matter of some importance where agriculture is the chief industry and it is not possible to utilize portions of the national income derived from other industries. In large measure, of course, the expenditure proposed is of a capital nature, the Committee were working in the atmosphere created by the Colonial Development and Welfare Vote, and the natural expectation is that the capital expenditure will in due time produce a commensurate or more than commensurate addition to annual real income. The effect of the proposals is mitigated to some extent by reservations such as that export industries receiving assistance must submit to output control and that land rehabilitated at large expense should be acquired by the State. It is no doubt true that most communities are capable of producing a much higher level of goods and services than they are geared to under the *laisser-faire* system, but nevertheless it is as well to make sure that the goods and services provided can be paid for, that they are not provided for one section simply at the expense of another. Improvement of production and marketing should precede enjoyment of the results.

A LEADER OF RESEARCH

I should like to state some of the more obvious reasons for Rutherford's extraordinary power as a leader of research. First, of course, there was his own unique and apparently almost intuitive grasp of the essentials of a problem. Next his interest in the course of an investigation and his impatience to know the result were so passionate that they inevitably infected even the laziest of his co-workers. Then there was his incorrigible friendliness to even the least worthy of his research men; a man who is invited regularly to Sunday supper at his professor's house, who meets him nearly every day across the laboratory tea-table, who is generally treated as the social equal of an emeritus professor, and who is constantly and pointedly asked how his work is getting on, is likely to do more and better work than one who is left to feel that nobody wants him or his results very much.

Prof. H. R. Robinson, F.R.S., quoted in *Nature*.

THE ROLE OF THE FOREST

By R. M. Graham, Forest Department, Kenya

Once in every five years, in peace-time, a conference of senior forest officers of the Empire is held, with the object of enabling these officers to exchange ideas, and to see for themselves how problems, common to Forest Services throughout the world, are met under varying conditions. Papers are read, discussions are held and plans are made, where these are feasible and necessary, for dealing with matters affecting forestry interests in the Empire.

At shorter intervals many progressive Forest Departments such as those in India and Malaya and more recently Nigeria, hold local officers' conferences to discuss slightly more parochial matters. In Kenya, on occasions, Administrators, Agricultural or Veterinary officers also meet. The fundamental idea behind all these gatherings is to prevent waste, i.e. overlapping of effort; to enable officers to be kept informed of the latest developments in policy and to encourage discussion as to the best methods of carrying out this policy.

In Kenya, the Forest Department is responsible for the management of an estate of some 3,648,000 acres, that is by far the greater portion of those areas of Crown land which have not as yet, been set aside as native land units, or as alienated farms or townships. The ordinary citizen, whose well-being depends to an even greater extent than he realizes upon the proper distribution and management of forest reserves, might well ask whether there is a co-ordinated forest policy in East Africa, and whether an annual inter-territorial conference of Conservators, as well as an annual conference of local Forest Officers, would not result in improved forestry practices which would in the end be of direct benefit to him. Since all such conferences are designed to promote efficiency in the planning and execution of reasoned policies it might occur to him that it would be worth while to establish a standing committee, consisting of fairly senior officers of various departments concerned with the management of the land and with the welfare of the African and hence of all the inhabitants of East Africa. Such a committee, meeting regularly every two or three months would serve as a permanent liaison and could assist very materially in the drawing up of plans on general policy and development made by any of the larger departments. It would correspond, roughly, to an embryonic Department of Land Planning, to co-ordinate the activities of all those chiefly concerned in the allocation and utilization of land; and it would result in all major, as well as many minor, items of departmental policy being discussed and examined from the viewpoint of various services, before being accepted and put into operation.

The following quotations from an American source are apt:—

"Wise use (of forests) for stability of rural economy requires that forestry and forest industry must be related in a positive way to the needs of the community through planning. Therefore forest industries must be adjusted to the forest resources and to the market."

Again:—

"As a general principle forests should be managed in a way that will contribute most fully to developing and maintaining the best possible kind of rural economy. This means working with community planning groups, and not as forestry pure and simple."

I might add that very similar remarks could be made about the Departments of Administration, Education, Agriculture, Health and Public Works, and that a very strong case could therefore be made out for the maintenance of a permanent liaison committee, or at the very least for *regular* meetings of a standing interdepartmental committee.

There are still too many people who do not realize the full significance of forests in our economy. A few are actively hostile towards our aims, though the majority are merely indifferent. It is extremely important that the Forest Department should enjoy the goodwill and co-operation of the people if it is to take its full share in the proper development of Kenya. It can hardly be denied that the social advancement of the country depends almost entirely on the conservation of rainwater, and on the availability of adequate supplies of cheap and suitable sawn timber. The notes which follow represent an attempt to give, briefly, the arguments on which this statement is based.

Forests are maintained, or created where necessary, by Governments for the benefit of the inhabitants of a country, and not merely to provide a few enthusiasts with an interest-

ing job. They are beneficial for three main reasons:—

(a) They conserve rainfall, prevent soil-deterioration on certain types of land and exert a modifying influence on local climates.

(b) They provide timber, fuel and various minor products.

(c) They are a desirable asset for aesthetic and recreational purposes.

In tropical countries, especially where rainfall is only moderate and desiccating winds prevail at certain seasons, the first of these reasons is by far the most important. Forests commonly check the surface flow of rainwater on sodden land, allowing the greater part of it to be absorbed into the soil, whence it is recovered in the form of springs and perennial streams, or as water from bore holes. "Green belts" break the force of high winds and restore moisture to the atmosphere. Where the water-table is exceptionally high, some types of forest enable potential swamp land to be utilized for the production of timber and fodder crops.

As regards the second point, timber is still an essential commodity. It is possible to build in stone and concrete, to furnish in glass and steel and to cook food in ovens heated by gas, coal or electricity. In countries where these things are a commonplace, much timber is used for the production of paper-pulp, artificial silk and a variety of other articles. We need hardly concern ourselves with such matters in East Africa as yet. Here, the great majority of Europeans and Indians want sawn timber for housing and furnishing, while the African uses quantities of poles or split slabs for the same purpose. All races, except for a few people in the largest towns, use firewood for cooking and heating. The railway and most local factories also use much wood fuel.

The third reason for preserving forests, i.e. for aesthetic and recreational purposes, as sanctuaries for certain birds and animals, and as an added attraction to the tourist, is obvious enough.

Forests may therefore be divided, broadly speaking, into (a) Protection, and (b) Production units. Timber and fuel may be obtained legitimately from some protection areas, while blocks maintained primarily for production will continue to function in their protective capacity under proper silvicultural management. Nevertheless it is wise to remember always that the distinction exists. Although from time to time it may be decided that land reserved in the first instance for timber production might now serve a more useful purpose under agricultural crops, yet serious consequences may follow permanent deforestation of protection areas.

The indigenous forests of East Africa vary a great deal in composition. There are mangrove swamps on the coast providing poles for building purposes, fuel and tan-bark; valuable mvule and African mahogany in the warmer districts; camphor, cedar, podo and olive in the Highlands; dense bamboo on the upper mountain slopes, and various other types of vegetation including open savanna and thick bush. Many of the less heavily wooded areas are of great local importance. Among the timber trees a few are excellent of their kind; though it frequently happens that the most productive natural forests are by no means the most conveniently situated from the point of view of the consumer. There is nothing unusual in this, nor can anything be done about it excepting to make the necessary transport arrangements where it pays to cut the timber. But planting schemes, including for present purposes, work done to improve and encourage natural regeneration in existing forests, could and should be based on intelligent forecasts of market requirements throughout East Africa, and possibly further afield. These forecasts must take account of the long periods required to mature a tree-crop, ranging from about eight years for fuel, to about one hundred and fifty years or more for certain cabinet woods.

In East Africa, the prosperity of each territory is linked, to a certain extent, with that of the others. But the prosperity of each depends, ultimately on its treatment of the soil. The first duty of a Forest Department, therefore, is to maintain, or if necessary to create forest reserves where these are wanted in connexion with water and soil conservation (protection reserves). Such forests can usually be exploited to a greater or lesser degree for the production of timber and fuel, so long as cutting is strictly controlled.

Here I should like to stress the point that protection forests may and should include not only existing high forest, where this is of importance, but also strategically selected blocks of bush and scrub. These latter may represent local climax types, the vegetation of which is incapable of being improved to any great extent owing to climatic conditions. On the other hand they may, as a result of protection and

proper management, develop into useful local production areas. In either case protection forests should be proclaimed and maintained wherever they are necessary with or without the consent of the present owners and entirely without reference to their revenue-earning potentialities. In the long run it matters not at all to whom such forests belong, so long as the State insists on their being treated in such a way that they, and adjacent lands, do not suffer through their mismanagement.

After Protection comes Production. The next step, therefore, should be to see that all inhabitants of the country have opportunities of obtaining, or of purchasing at reasonable rates, necessary timber and fuel, without having to destroy existing vegetation in places where this ought to be maintained. An African, or for that matter a European, will not usually preserve an important area of forest for the benefit of the community if he is in immediate need of timber. But if alternative sources of supply are made available governments will have a moral right, and hence be in the best position to invest themselves with a legal right, to insist on the preservation of vegetation where this is desirable. If they fail either to protect such vegetation or to provide the local populace with reasonable alternative sources of supply within a fair time limit they are obviously, in some respects, failing to govern. In some cases it might even be necessary at first to provide fuel or poles free since Africans long accustomed to free cutting rights do not take kindly to the idea of royalty payments. The solution to this problem will be to provide good material and to educate the African, slowly, into buying it. The proper care of the land is of far greater importance than the collection of royalties under such circumstances.

The third main duty of a Forest Department, in its role of estate manager to the public, should be to utilize the productive capacity of the land under its control as fully as is economically desirable, at the same time maintaining or improving the fertility of the soil. This does not mean that all plantable land with a low actual yield of timber should be cleared and planted with other trees forthwith. It does mean that the forest estate should be run as a business concern. Unwanted land should be handed back to Government for sale to farmers who will utilize it. But relatively large areas of land must, for the vital purposes of water conservation and control, be kept under some sort of forest cover. If these lands are capable of being made to yield valuable crops of timber, while still fulfilling their main function, then every effort should be made to grow such crops, providing always that the work is carried out according to a plan carefully designed to produce the quantities and the type of timber which, it is considered, will be needed. It should be obvious that local markets in East Africa will expand enormously when the native population starts to use sawn timber for building and furnishing. But if it is thought that the land which it is necessary to maintain under forest is capable of producing, in the near and more distant future, more timber than can be consumed locally, then the possibilities of fostering an export trade, preferably in the form of manufactured or semi-manufactured goods, must be studied in detail. It takes many years at best to produce a millable log. Bold, intelligent planning is urgently needed now.

Normally the organization of supplies of wood-fuel or poles must be a strictly local business. These are cheap and bulky commodities, but expensive to transport. Suitable trees of some species or another can be made to grow almost anywhere, and fuel and pole supplies should therefore be grown as near to the market as possible. Sawn timber, however, especially if it is semi-manufactured into the component parts of doors, windows or standardized wooden houses, can stand considerably greater transport charges even where there are, as yet, no railways. It would be to the advantage of all concerned if a co-ordinated forest policy for the production of cheap building timber for the African operated throughout East Africa. It is easy to say that this is at present unnecessary. The facts remain that *suitable* natural timber stocks are running low, that it takes time to grow saw logs, and that if we wait for the demand to materialize before planting the trees, after having cut out most of the existing accessible timber in the natural forests, we shall find it a little embarrassing to explain our conception of trusteeship to the African. It is not just a question of timber. What will be wanted is accessible, cheap and suitable timber, and a great deal of it. As it will be impossible to grow enough naturally termite-resistant timber in the time, arrangements may have to be made to supply a certain quantity of treated, termite-proof material when the time comes.

It might be of interest to quote a few figures here illustrating the general trend of consumption in Kenya before the present war. During

the period 1934-1939, the following amounts of timber in the log were sold from our Forest Reserves:—

1934	1935	1936	1937	1938	1939
C. ft.	*C. ft.*	*C. ft.*	*C. ft.*	*C. ft.*	*C. ft.*
635,638	952,826	921,597	981,217	966,546	1,167,223

The rise in sales in 1939 was due largely to an expansion in local trade before the outbreak of war, and as there were also several mills cutting timber on privately owned land, we can assume that the local demand was for about 1,200,000 c.ft. of round timber, representing, say, 720,000 c.ft. of sawn timber. But in addition to this 343,000 c.ft. of sawn timber were imported, making a total of 1,063,000 c.ft. of sawn timber. Practically none of this was utilized directly by Africans, though the Government and Railway took considerable quantities. The non-native population of Kenya consisted of about 20,000 Europeans and 60,000 Indians. These 80,000 people, therefore, consumed or exported about 1,063,000 c.ft. of sawn timber, excluding 25,000 c.ft. exported for war purposes. This works out at 13½ c. ft. per head.

There are some 3,500,000 natives in Kenya. It is fairly safe to assume that the total in fifty years time will have risen to 4,000,000. The Medical and Education Departments are doing their best to induce these natives to build and furnish better houses, preferably by using a certain amount of sawn timber in lieu of mud. Many of them would be only too willing to do so now, if they could get *cheap* sawn timber. In the West Indies, in parts of West Africa and in certain French colonies many urban Africans have advanced rapidly and now demand something considerably better than a mud hut, in which to live. There is no possible justification for supposing that this will not occur in Kenya. The process has barely started but the war will undoubtedly hasten it, and the demand for better houses will increase progressively once the African realizes that timber is available at a price which he can afford, if he works and saves. Many Indians occupy houses which are very little better than mud huts. Relatively few African employees are at present well housed. If, by 1989, even no more than one-twentieth of the native population of Kenya were to want as much timber as was consumed by the *average* non-native in 1939, then we should have to produce anuually about 2,700,000 c.ft. of sawn timber for the African alone, i.e. about four times as much as was cut from Forest Reserves in 1939 for export as well as for local needs. Practically the whole of this would have to come from plantations, as accessible indigenous forests will have been very nearly denuded of cheap, suitable building timber by that date.

Previous to the year 1930, less than 2,000 acres of exotic softwoods had been planted in Kenya. Between 1930 and 1939 inclusive, some 9,675 acres were established, the average rate of planting being 967 acres per annum. Let us assume that the rotation, i.e. the time which it takes a crop to ripen, will be 50 years, and that the total yield per acre of round timber, inclusive of thinnings of 6-inch diameter and over, will be 8,000 c.ft. Let us further assume that the recovery of sawn timber will be 60 per cent of the volume of round timber. The average annual output of sawn timber from exotic softwoods plantations in the period 1980-1989 will then be 4,644,000 c.ft. of which rather more than one-third might be prime timber, free from knots and of exportable quality. Hardwoods and cedar will still be available, at a price, from the natural forests, but over 13,000 acres of cedar plantations will not really come into bearing until after the middle of the next century.

It is certain, though, that the non-native population will still be consumers, probably to the extent of at least 2,000,000 c.ft. a year so that the minimum local requirements by 1989 might be in the region of 4,700,000 c.ft. per annum—always providing that by that date not more than one-twentieth of the native population will want reasonable housing and furniture. This amount of timber could be obtained annually from some 49,500 acres of cypress or pine, grown on a rotation of 50 years, and yielding 8,000 c.ft. of round timber per acre. But by the time that three-quarters of the native population become moderate users of sawn timber, production will have to rise to at least 40,500,000 c.ft. a year, equal to the estimated yield from 422,000 acres of cypress or pine. It is true that some considerable time must elapse before there is likely to be a demand from the African for this quantity of timber; but nobody is in a position to say just when this demand will arise, nor will it avail to attempt to gloss over errors of policy by speeding up the planting programme at the last moment. Nature will not be hurried and millable logs mature slowly.

The estimates of yields and rotations given above must, for the present, remain estimates only. I believe them to be reasonably accurate for the best planting sites, though figures which differ from them very considerably are

also quoted. It must be remembered that much of the timber produced, especially from thinnings, will be extremely knotty, though quite serviceable for cheap building purposes.

As regards fuel, it is a sorry, not to say a scandalous, state of affairs that in some quite fertile districts Africans have now to use dried cowdung instead of wood fuel. If the land in these districts is producing such valuable crops that none can be spared for fuel plantations, then the inhabitants could presumably afford to buy fuel from elsewhere, and they should be educated into doing so. If, on the other hand, the deficiency is due simply to the fact that available natural supplies have been cut out, and that it has been nobody's business to regulate the rate of cutting, or to replenish supplies by making State or Native Council plantations, then surely this indicates some radical fault in policy or in organization.

Those there are who do not believe that a vigorous forest policy is a vital necessity for Kenya, both from the point of view of the conservation of water supplies, and also for the production of timber. They may argue that Kenya natives are not yet fit to occupy clean hygienic houses; that if the native chooses to lower the value of his own land by overstocking and by deforestation, it is entirely his own affair; that if he has not the sense to undertake afforestation programmes where necessary, paid for out of tribal funds, there should be no call to spend Government money on this work in the near future. It would, I fear, be a waste of time trying to make such people realize the true facts of the case. The point might be raised, however, that as it is not possible to say exactly when the African will want sawn timber in quantity, nor how much he will take, the Forest Department will not be justified in growing large stocks which might not, in the end, be saleable. In practice there are several answers to this query:—

(i) It is quite impracticable to attempt to plant, annually, exactly as much timber as will be wanted some fifty years later. A surplus will be better than a deficit.

(ii) It is a well established fact that, where large quantities of cheap timber are made available, consumption increases very largely. The African is starting more or less from zero. So long as the price is right, it would be impossible for us to raise too much timber.

(iii) Trees need not be felled and sawn up in any particular year. Even if they are being grown, nominally, to the age of fifty years only, it will do them no harm if they are left to grow on for a further ten or twenty years, i.e. if it appears that, owing to the cost of converting logs to planks, more trees are being planted than can be sold, the rate of felling can easily be adjusted until the demand improves.

(iv) Practically no account has been taken of the possibilities of fostering an export trade in manufactured or semi-manufactured timber. Large areas of Forest Reserve in Kenya, necessary for water conservation, are at present extremely poorly stocked with useful timber species. There is plenty of such land available on which to grow all the timber we are likely to need and to provide a surplus for export if production outstrips local consumption. If we have enough good, cheap timber to offer, it is extremely unlikely that it will be unsaleable. Much will depend on the price, and the price of the sawn or manufactured timber will depend largely on the turnover.

A great deal has been said and written about agricultural policy and practice. Little is heard about forests, so long as timber and fuel supplies are forthcoming in reasonable quantities and so long as the public are not treated to a display of forest fires. Farmers, administrators and tax-gatherers, however, should remember that the value of agricultural land, the source of "money", depends ultimately on perennial water supplies, and that in East Africa these water supplies depend on the conservation, mainly through the agency of forests, of rainfall. A strong, long-range forest policy, adequately financed, would be very well worth while even if for the next fifty years no surplus profits were paid into general revenue by the Forest Department. Privately owned woodlands and fringing forests along streams of little apparent value are too often thoughtlessly destroyed. Water catchment areas in native reserves are in places losing their conservation value owing to overstocking. Under these circumstances the African is less and less likely to surrender land for forest reservation, even though he retains the ownership of the land, unless he can be made to see how this is going to benefit him personally. The necessity for making the best possible use of existing forest reserves for production purposes is already urgent. The task of selecting, reserving

and protecting other strategically placed areas, not necessarily of high forest, to serve as more local protection and production areas is even more urgent. In the true interests of the country, Government should override local opposition where reservation is obviously needed; but they should also educate the people, and provide the staff to do this.

It is useless to suppose that Kenya can progress unless the African and the European advance on parallel lines, working together and sharing in the prosperity of the country. Until the African can afford a table, a chair, a bed and a house that will not disintegrate when it is washed, he will be at a hopeless disadvantage. Sooner or later, however, he will reach this standard of living, and any factor which seriously retards his progress will likewise hinder the development of a prosperous Kenya. We have all heard the view expressed that the "old fashioned" natives in blankets were much more satisfactory labourers than the discontented younger generation, wearing European style clothing and travelling round on bicycles. There is some truth in this, but the phase will pass when the African has had time to adjust himself, in his own way, to the impact of civilization. In the meantime two essentials for Kenya are (*a*) a sane, and if necessary, an apparently ruthless land utilization policy; and (*b*) an abundant supply of cheap but suitable sawn timber. Without these, agriculturists, doctors, administrators and educationalists of whatever kind can make no real progress in their task of educating the African.

[The Conservator of Forests, Kenya, sends the following comments with this article:—

While endorsing Mr. Graham's plea for foresight in estimating and providing for future requirements I think he is unduly pessimistic in some respects, certainly as regards Kenya. We have of course been cutting much more heavily during the war than previously but cutting in peace-time had been far below the capacity of the forests and I know no justification for the statement that in East Africa "suitable natural timber stocks are running low". Mr. Graham's figure of 13½ c.ft. of consumption per head is not really a fair figure for the average European and Indian consumption of softwoods as it includes the extra consumption due to preparations for war in 1939, considerable exports and twenty-three per cent of hardwoods. If one allows for all these the softwood consumption figure was about 5 c.ft. per head.

There is also the matter of the yield from plantations. The main point is that it is planned to cut the softwood plantations at 40 years, when average diameter will be 18 inches and the average yield per acre about 6,000 c.ft. In Australia and New Zealand, plantations are cut at 25 years old and yield excellent timber from which European houses are being built satisfactorily. In Mr. Graham's period of 1980-89 the average yield from the softwood plantations will not be the 4,644,000 quoted but for the first four years it will average about 7,000,000 and thereafter will depend on whatever planting we do in the next few years. Even under present circumstances the rate of planting has nearly doubled since 1939 and will further accelerate after the war. Undoubtedly Kenya should be able to supply some softwood to Tanganyika and Uganda but it would be better of course if they could grow some for themselves in the areas where conditions are suitable.]

(*Received for publication on 25th February,* 1944).

A patient pursuit of facts, and a cautious combination and comparison of them, is a drudgery to which man is subjected by his Maker if he wishes to obtain sure knowledge.

Thomas Jefferson quoted in *Nature.*

Systematic zoology, as exemplified by Mr. G. M. Allen's "Checklist of African mammals (1938)", provides some surprises. We may have got accustomed to the hyraxes being classified next to the elephants. Are we prepared to find *Homo sapiens* on the same page as the pole-cats?

The first step in the science of agriculture is the recognition of soils and of how to distinguish that which is of good quality and that which is of inferior quality. He who does not possess this knowledge lacks the first principles and deserves to be regarded as ignorant.

Ibn-el-Awam, *ca.* 1170 quoted in *Geographical Review.*

The aim of science should certainly be to remove the mystery from natural phenomena, but not to take away wonder, or that quality of nature which allows for the development and play of aesthetic appreciation.

Dr. Fraser Darling.

ORIGINS OF SOME EAST AFRICAN FOOD PLANTS

PART I

By P. J. Greenway, Systematic Botanist, East African Agricultural Research Institute, Amani

In a recent issue of a local journal an author was puzzled because Vasco da Gama, the Portuguese explorer, when he anchored in April, 1449, off the north-east Tanganyika coast in view of the Serras de San Rafael, was provided by some Mohammedans with a supply of oranges. The author had thought that the Portuguese introduced the orange to East Africa. As this view is incorrect and some of us may know little of the derivation of many of the food plants grown in East Africa I thought it might be of interest if an account was given of their origins.

I am aware that in attempting to trace the origins of some of the food plants found in East Africa I am up against difficulties similar to those described by Swift:—

"Geographers, in Afric maps,
With savage pictures filled their gaps,
And o'er unhabitable downs,
Placed elephants for want of towns."

I have taken the less picturesque course of leaving gaps, which is unavoidable because some of the food plants, for example, the pea, coco-nut and the gourds, are of such ancient cultivation that their origins are lost.

The ethnologists do not agree as to the early origins and distribution of domesticated plants and animals, neither is it known where or when primitive man first became a cultivator. Peake and Fleure suggest as the birth-place of primitive agriculture what Breasted called "the Fertile Crescent", a belt on the northern fringe of the great desert of Arabia, running from Moab northwards to the foot of the mountains of Eastern Asia Minor and thence south-eastwards along the foot of the Zagros range, which divides Mesopotamia from the Persian plateau. Others claim Egypt as the original home of vegetable food-production. Recently Vavilov, a Russian scientist, has undertaken some interesting ethno-botanical research based on the hypotheses propounded by Willis. These were that in comparing wild species of plants which have similar modes of dispersal, those with a wider distribution may be accepted as the older. Also the longer a given species has been established in a given area, the more diverse will be the species or subspecies found there. Vavilov takes the centre of dispersal as that area which shows the greatest variety of spontaneous undomesticated species and he has made advances in his search for, and discovery of, vast numbers of spontaneous species and variations allied to domesticated plants known to and used by man. Vavilov's conclusions are that there are seven independent centres of primary agriculture in the world and that they are confined to the tropical and sub-tropical mountains or plateaux, namely:—

(*a*) In Asia, three centres: (1) South-western Asia, including the interior of Asia Minor, Persia, Afghanistan, Turkestan and north-western India; (2) India proper, the Hindostan peninsula and the valley of the Ganges; (3) the eastern and central mountains of China, including the upper courses of the Hun-Ho and Yangtse-Kiang.

(*b*) The Mediterranean region, embracing the Iberian, Apennine and Balkan highlands, the coastal parts of Asia Minor, Egypt with the Nile, and the winter rainfall areas of Palestine and North Africa.

(*c*) In Africa, the mountains of Ethiopia and the eastern sources of the Nile.

(*d*) In America, two centres: (1) South Mexico, including part of Central America; (2) Peru and Bolivia.

(*e*) In Africa, Vavilov regards the mountains of Ethiopia and the eastern sources of the Nile as unexpectedly important, more especially on account of their accessibility to the ancient Egyptian civilization. In these regions certain wheats, barley, sorghum and coffee, teff, flax, etc., originated.

Very few historical records of East Africa exist till the end of the fifteenth century when on the advent of the Portuguese to the East African coast we get a glimpse of conditions of life there, though not of the interior. There are no native ideographs like those in the Nile Valley, those that have been discovered being by primitive artists of animal and human figures only.

The first record of plant introductions into southern Africa is that by Herodotus, the Greek historian, *c.* 484-425 B.C., and I quote from Rawlinson's translation, Book 4, Ch. 42: "Necos, the Egyptian king sent to sea a number of ships manned by Phoenicians with orders to make for the Pillars of Hercules, and return to Egypt through them, and by the Mediterranean. The Phoenicians took their departure from Egypt by way of the Erythraean Sea, and so sailed into the southern ocean. When

autumn came they went ashore, where ever they might happen to be, and having sown a tract of land with corn, waited until the grain was fit to cut. Having reaped it, they again set sail; and thus it came to pass that two whole years went by, and it was not till the third year that they doubled the Pillars of Hercules and made good their voyage home. On their return they declared, I for my part do not believe them, but perhaps others may, that in sailing round Libya they had the sun upon their right hand. In this way was the extent of Libya first discovered.". The interesting corroborative detail, in which Herodotus did not believe, seems to prove that these navigators really did succeed in passing round Africa and the evidence that they introduced some food-crop into Africa south of the Sahara is correspondingly good.

The earliest and most consecutive record of the imports and exports of the Red Sea, the Indian Ocean and the Persian Gulf, their markets and their peoples is the *Periplus of the Erythraean Sea* written by a Greek merchant-seaman of Berenike, a port on the Red Sea coast of Egypt, he was a Roman subject, who about A.D. 60 steered his vessel down the Red Sea and into the Indian Ocean and brought back the first consecutive account of the Indian Ocean and East African coast. The *Periplus* records the export of wheat and spices from the port of Zeila, cinnamon from Berbera, Ras Kantara, Ras Hafun on the Somaliland coast and coco-nut oil from further south. Also wheat, rice, sesame oil and "honey" from the reed called *sacchari* from India and the Gulf of Cambay as ships also came from the Indian coast of the Indian Ocean. It also shows how the Arabs catered for the East African trade, importing lances, hatchets, daggers and awls and various kinds of glass and cloth, and in some places a little wine and wheat for obtaining the goodwill of the savages. In exchange they obtained a great quantity of ivory, rhinoceros-horn and tortoise-shell.

The accounts of the great Arab traveller, Ibn Batuta, born in Tangier in A.D. 1304, died 1378, are the next early records of importance as he visited most of the chief settlements down the East African coast as far as Kilwa. He describes accurately what he saw and was apparently a lover of good living; he also visited amongst other places the Persian Gulf, India, Sumatra, and China.

Marco Polo, c. A.D. 1254-1324, a Venetian, another great medieval traveller, is chiefly famous for his Asiatic records, but he also gives some accounts of East Africa which are apparently based on other travellers' tales.

In passing I must mention that neither of these great travellers kept any journals. Marco Polo dictated his experiences to Rusticiano or Rustichello of Pisa when he was in prison in Genoa in 1298, and Ibn Batuta dictated his narrative of 28 years' wanderings during which he covered on his main journeys alone over 75,000 miles. This was taken down by Mohammed Ibn Juzai just after Batuta had returned from Timbuktu and Gogo, 1352-1354, and was concluded on the 13th December, 1355.

If we turn to native agricultural practices we get little help as the cultures are frequently mixed and one very often finds the digging stick, which is considered to be the most primitive form of agricultural implement, used side by side with the hoe, which is of later evolution, and the latter used with the plough, a European introduction into East Africa. What information we can obtain from the East African tribes themselves is based on tradition and not on written records. For example, the Baganda with their tradition about the origin of the banana, the Babembas' tradition of their first ancestor, Citi Muluba, travelling from the Luba country carrying in his hair the seeds of sorghum, finger millet, Kaffir beans, cow peas, pumpkins, etc. Tradition often does not go back very far in historical time and even with historical records, where the less common plants are mentioned, one is often left guessing about their correct identity because vernacular names are used instead of scientific.

In this account I am grouping the various food plants under the headings: Roots and tubers; leaves; fruits; fruits used as vegetables; pulses, beans, grams, and peas, etc.; grains; oil seeds; spices and condiments and beverage plants. Under these headings I have arranged the various species in alphabetical sequence according to their common names, except where they are closely related, when they are then grouped together. Swahili names when available are quoted following the botanical names. A list under continents of origin with a bibliography of the books and papers consulted concludes this account. The more temperate vegetable and fruits in use by Europeans are not included.

Roots and Tubers

African Arrowroot, *Tacca involucrata* Schum. and Thonn. *Mlanga, Mwanga* the plant, *Uwanga* the flour. This widespread tropical African plant was at one time con-

fused with the Malayan-Polynesian plant, Tahiti or Fiji Arrowroot, *T. pinnatifida* Forst. On the mainland the tuberous roots of *T. involucrata* appear to be used only as a famine food but in Zanzibar it is one of the chief constituents of the sweet-meat *halua*.

CASSAVA, *Manihot utilissima* Pohl. *Mhogo*. This plant was in cultivation in Central America when the New World was first discovered and one traveller, Willem Piso, who accompanied the Count of Nassau Siegen to the Dutch Settlements, enumerated nine races in Brazil in 1637. It was taken from America about 1500 but it is not known when it was introduced into Africa. It may have been an early introduction after that date as there are races in East Africa not yet detected in America. At the same time it is not recorded in Goa or on the Malabar coast at an early date and a record it not found until 1786 of its introduction into Ceylon from Mauritius where it had been introduced from Brazil by La Bourdonnais, its Governor, between 1735 and 1745. In 1794 it was brought into the East India Company's new Botanic Garden in Calcutta. It had reached Java before that date but not before 1692, as Rumpf or Rumphius (1637-1702), a Governor of Amboyna, and a great botanical observer, did not record it in his writings. Its first record in East Africa appears to be that by Lt. Bissel, of the British man-of-war *Daedalus*, in 1799 in Zanzibar. He speaks of it as a curiosity and gives its native name "*Mohogo*", together with *Farina da pas* of the Portuguese, and says it is much eaten by the natives. It apparently reached East Africa from Réunion or Mauritius or by Portuguese slave ships from West Africa in the first half of the eighteenth century.

Cassava is not grown by all tribes, partly because all climates are not suitable and partly because of prejudice. For example the Wazigua in Tanganyika in spite of seeing it in cultivation by their Wadigo, Wasegeju, Wabondei, Washambaa, Wakwere, and Wadoe neighbours would not at one time plant it as they said it made their women barren. Those peoples who grow it recognizé many varieties besides the sweet and bitter kinds.

ONION, *Allium cepa* L. *Kitunguu*, (pl.) *Vitunguu*. This is a Western Asiatic plant which reached Greece and Italy at an early date. It spread to Egypt and reached India at a very remote date and is known in the Philippine Islands by a Sanskrit name which suggests that it reached Malaysia from India. It is believed to have reached East Africa through Arab traders about the fourteenth or fifteenth century.

It does not appear to have been established as an important crop and those varieties now in cultivation were introduced at the end of the last and during the present century.

GARLIC, *Allium sativum* L. *Kitunguu saum*, (pl.) *Vitunguu saum*. This is an Asiatic plant that has been cultivated since long before historic times, has been in India from a remote period and is believed to have reached Egypt from Persia. It is not extensively cultivated in East Africa and the date of its introduction is not known, but it was no doubt brought in from time to time by Arab and Indian traders by way of the Persian Gulf and from India.

KAFFIR POTATO, *Coleus* spp. The botany of the Kaffir Potato is very confused and requires investigation. The following are the recorded edible species in Africa:—

C. barbatus Benth. recorded from the Erkowit Mountains, Red Sea Province of the Sudan, Eritrea, Ethiopia, Uganda, Kenya and between Tabora and Kahama in Tanganyika.

As it is also recorded from Arabia, Ceylon and India it may be that this plant has been introduced from Arabia or India by way of the Red Sea and has spread southwards through Central Africa by means of native migrations from the north.

C. dysentericus Baker (syn. *C. rotundifolius* A. Cheval., *C. salagensis* Guerke? and *Plectranthus coppini* Cornu) recorded from the French Sudan, Sierre Leone, Gold Coast, Togo, Northern and Southern Nigeria. Three forms have been described, var. *nigra* with tuber blackish-brown, var. *rubra* with reddish-grey or reddish-yellow tubers and var. *alba*. In spite of a fairly widespread distribution in West Africa some authorities consider it Ethiopian in origin.

C. edulis Vatke is recorded from Ethiopia but it appears to be known only from herbarium specimens. One of its collectors, Quartin Dillon (d. 1841), a plant collector on a French mission to Ethiopia (1839-1843), said of it that it was much cultivated under the name *Daunech* in numerous gardens around Kouaieta at an elevation between 6,000 and 7,000 feet in the province of Godjam.

C. esculentus (N.E. Br.) G. Taylor. This was first described under the name *Plectranthus* from plants grown at Kew from Natal and the same plant was also described under the name

P. floribundus N.E. Br. and var. *longipes* N.E. Br., the former also from Natal and the latter from Nyasaland. It was next discovered in the French Congo and the Upper Ubangi-Shari and described under the name *Coleus dazo* A. Cheval. It has also been transferred to the genus *Englerastrum*, but its correct position is in the genus *Coleus* and as its earliest specific name under which it was first described must be retained it should be known as *C. esculentus*. It is found in Natal, Transvaal, Gazaland, Portuguese East Africa, the Rhodesias, Nyasaland, south-west and north-west Tanganyika, Urundi, Uganda, Angola, the Belgian and French Congo, northern Nigeria and the Upper Ubangi-Shari. The natives in south-west Tanganyika where it is an important item on their markets, recognize a great number of varieties which vary considerably, from an angular irregular-shaped tuber about an inch in diameter to a sausage-like tuber 1½ inches in diameter and 8 inches long.

From the evidence available it would appear that the Kaffir Potato is African in origin and that there were probably two centres of dispersal, one south-central-Africa, Nyasaland or Northern Rhodesia, the other Ethiopian. At the same time one cannot overlook the possibility that all these species may have evolved from one common ancestor, such as *C. barbatus* of Arabia, India and Ceylon and which may have been brought in during the Abyssinian invasions of Arabia in the fourth and sixth centuries after Christ.

POTATO, *Solanum tuberosum* L. *Viazi Ulaya*. The potato is a native of the Andes where it was cultivated. About 1532 the Spaniards found it and carried it to sea as ship's provisions and through the capture of a Spanish ship by a British the potato was brought to Ireland where it slowly took its place in cultivation and spread, at first, mainly I think as a famine food, to other countries. The Spaniards took the potato to the Philippines at an early date and it is said to have been brought to India in 1615 but evidence of this has not been produced, there is, however, a description of some gardens in Surat and Karnátak in 1675 in which potatoes and egg plants were growing. Its introduction, probably by missionaries into East Africa, cannot be earlier than the late nineteenth century. Through the activities of the agricultural departments its cultivation is general in most highland districts and as a food it is much liked by some tribes.

RADISH, *Raphanus sativus* L. *Mfigili* the plant, *Figili* the root. The exact origin of this plant is not known, but it is believed to be derived from three European species, one of which, *R. raphanistrum* L., extends eastwards into Irak. It was known in ancient Egypt before the Greeks and Romans who called it *rhaphanis* and *radix* or *radix syria* respectively and it was in cultivation in Assyria at an early date. The date of its introduction into East Africa is not known but it was probably brought in by Arab or Indian traders from the Persian Gulf or India. It is to be met with in coastal markets, especially in Zanzibar.

SWEET POTATO, *Ipomoea batatas* (L.) Lam. *Viazi Vitamu*. This is native of America and was first brought to Europe by Columbus (*c.* 1451-1506) the Genoese discoverer of the New World. It soon became a familiar plant in western Europe and is the potato mention by Shakespeare in the *Merry Wives of Windsor* (*c.* 1599) Act. 5 Sc. 5 "Let the skie raine Potatoes".

It has been suggested that it was known and used in China as early as the second and third century A.D., but there is evidence everywhere in its vernacular names that it is a late introduction to the East and that the Chinese plant is some other edible species.

The Spanish and Portuguese took it to Malaysia on their earliest voyages where it was adopted at once. It is thought to have come from there to Africa; but if they took it to the East it is at least as likely to have been introduced to their West African trading settlements. It is possible that the cultivation of the sweet potato has spread from both sides of the African continent. There are many varieties with native names.

TARO or EDDOES, *Colocasia antiquorum* Schott. *Mayugwa*. This is native of India and probably other parts of south-east Asia. It reached Egypt about the time of Christ and spread from there along the Mediterranean into Italy and Spain. It is believed to have been brought to East Africa at an early date and is thought to have spread through Africa from the ports about Zanzibar and from the Mediterranean across the Sahara. As it is a crop that likes rich land and plenty of soil and atmospheric moisture with high temperatures it is usually cultivated in, or on the margins of, swamps. The West Usambara and Kilimanjaro peoples recognized four to six varieties.

YAM BEAN, *Sphenostylis stenocarpa* (Hochst. ex A. Rich.) Harms. This plant was originally described from Ethiopia but is widespread in tropical Africa as far south as Rhodesia; it is indigenous to Africa. It grows from sea level to about 6,000 ft. and is more cultivated from Central to West Africa than in the coastal areas of East Africa. The seeds can be eaten as well as the tubers.

YAMS, *Dioscorea* spp. *Viazi Vikuu*. A recent monographer of this genus deals with six hundred and three species from all over the world, but of this number, Sampson only lists fourteen species as being crop plants in the British Empire. The monograph contains a tabular survey of the most important cultivated species of which there are eleven. Those in cultivation in East Africa are *D. abyssinica* Hochst. ex Kunth, *D. alata* L., *D. bulbifera* L. and *D. triphylla* L. var. *dumetorum* (Knuth.) R. Knuth.

D. abyssinica is Northern African, with a geographical range from Eritrea to Nyasaland, and by way of Uganda into the Congo and Cameroons.

D. triphylla var. *dumetorum* is Central African, with a geographical range from Uganda and Kenya to Natal and Angola and northwards to French Guinea and the French Sudan. It is also recorded in Jamaica.

D. alata, the Asiatic or Greater Yam, is a native of Tropical Asia; believed to have been brought by medieval voyagers from south-eastern Asia to the east coast of Africa. In the sixteenth century it was carried by the Portuguese to the west coast of Africa, and the eastern seaboard of the New World. It is not cultivated everywhere, being found in scattered places usually in areas of high rainfall in Kenya, Tanganyika, Zanzibar and Uganda into West Africa.

D. bulbifera, Air Potato, Potato Yam, is most likely Asiatic in origin. Prain and Burkill recognized eight varieties of the species from India, Burma, Assam, the Pacific Islands, Australia and Hongkong but none appear to have been described from Africa or the Americas. It may have been introduced from the East at a very early date as it has a much greater distribution in Africa than *D. alata*. It has been recorded from Ethiopia to Mozambique, Angola and West Africa and America.

The cultivation of yams in Tanganyika seems to be dying out. C. Holst (1865-1894) a German gardener and botanical collector at Mlalo, about 1890 recorded and described ten varieties cultivated by the natives in the West Usambaras; on a visit to the same area now one would have some difficulty in finding many patches of yams. One of the reasons for this is that cassava and sweet potatos are much quicker maturing and cassava is taking the place of yams because flour can be made from the former's roots but rarely from yams. Actually *D. alata* tubers can be converted into a meal that will keep for upwards of a year; it can be used as a substitute for wheat flour, but even in Asia it is seldom made into a flour.

D. sansibarensis Pax, found in Zanzibar, Tanganyika, Nyasaland and Madagascar has a superficial resemblance to *D. alata* but lacks the latter's square winged stem. It is often mistaken by the natives for *D. alata* in times of famine and is eaten with invariably fatal results. It probably contains the toxic alkaloid *dioscorine*.

LEAVES

BASTARD MUSTARD, *Gynandropsis gynandra* (L.) Briq. a widespread weed of the tropics and common in places throughout tropical Africa. Its leaves are an important spinach-like vegetable to the African and by some tribes it is often cultivated with other crops. The leaves are cooked fresh or can be dried and stored until wanted. The seeds contain an oil which has medicinal uses.

SPIDER FLOWER or BASTARD MUSTARD, *Cleome* spp. The leaves of a number of species are of importance as spinaches to the natives and *C. hirta* (Kl.) Oliv., *C. monophylla* L. and *C. strigosa* (Boj.) Oliv., all indigenous have been recorded as being so used. The first two are widespread throughout tropical Africa but the third is a strand plant restricted to the East African coast from Somaliland to Mozambique and to the Aldabra Islands. The seeds of some contain an oil that is also used.

HORSE RADISH or DRUMSTICK TREE, *Moringa pterygosperma* Gaertn. *Mlonge* or *Mronge*. This is found wild in Northern India and is now spread by cultivation throughout the tropics. Its date of introduction to East Africa is not known but it is suggested that it was introduced not by Indians, but by Arabs from Southern India or by way of Réunion into Zanzibar. Besides the flowers, leaves, and young fruits providing a useful but somewhat bitter vegetable, its roots are used as a substitute for horse radish; it is usually planted by the coastal peoples as a live fence-pole as it strikes easily from large stake-like cuttings.

LOVE-LIES-BLEEDING. *Amaranthus caudatus* L. *Mchicha; Mkulandi* has been recorded by Stuhlmann at Bagamoyo. Believed to be Asiatic and cultivated in the warmer parts of the world. It is widely distributed throughout tropical Africa and was collected by the early explorers such as Schweinfurth (1836-1925), one of the greatest travellers and botanists of modern times, at Matemma, Ethiopia; Schimper (*c.* 1838-1880), at Adowa, Ethiopia; Speke (1827-1864), and Grant (1827-1892), at Madi, Uganda, and by Burton (1821-1890), in the Lower Congo. It is used as a spinach and its Swahili name is also applied to several wild species that are eaten as pot herbs by the natives throughout East Africa. It is said to be cultivated as a grain crop in India and there are many references in literature to a similar use in Africa, which are not borne out by collectors' field notes on the numerous specimens of the species in the Kew and British Museum Herbaria. Only one specimen, collected by Scott Elliot in Sierre Leone, has this information, and this is suspect.

QUAIL GRASS, *Celosia argentea L.* and Cockscomb, *C. argentea* var. *cristata* Kuntze. *Mfungu*. This plant is Indian in origin but its date of introduction into East Africa and by whom is not known. It is often cultivated in gardens by Europeans as an ornamental annual for its flowers and is used in Zanzibar as a spinach plant. Two indigenous species *C. schweinfurthiana* Schinz and *C. trigyna* L. are used similarly by the African.

FRUITS

AVOCADO PEAR, *Persea americana* Mill. *Mapaya, Mpea, Mlangalanga.* A native of Central America and the West Indies, first recorded by the Spanish historian, Oviedo (1478-1557), in 1526. The tree was introduced into southern Spain in 1601, but does not appear to have reached the East Indies till about 1860. It was shortly afterwards established in Réunion and Mauritius, where it has run wild. In 1892 Sir John Kirk, the British Agent and Consul General in Zanzibar, said it had been introduced into Zanzibar "quite recently" and grew well. It was introduced into Dar es Salaam, Tanganyika, in 1896, from Natal. It was also planted at Mombo, Tanganyika, and first fruited in 1907. It is now common in Zanzibar and Pemba and has been established in other parts of East Africa. The fruits grown in Zanzibar and Pemba vary considerably in size and colour but it is possible to get good varieties.

BANANAS and PLANTAINS, *Mgomba* the plant, *Ndizi* the fruit. The banana, *Musa sapientum* L., the plantain, *M. paradisiaca* L. At one time some botanists included the banana under the same botanical name and in the early references to either the banana or plantain it is difficult to know which plant is being referred to because the early writers did not distinguish between the two. Plantains are characterized by wide open bunches and large angular fruits which are seldom eaten raw but are used as a vegetable, for making beer or as a sweet. Both bananas and plantains are most probably Malaysian in origin there being many races in Malaya. They were recorded growing at Mombasa about A.D 1300 and at Lamu in the fifteenth century and a Portuguese botanist, Garcia da Orta, who was along the East African coast in 1543 mentions the fine flavour of the fruits of those of Sofala in Mozambique. Both the banana and more especially the plantain may have reached East Africa at a very early date by way of the Hovas of Madagascar, a people who are said to be related to the Javanese.

It is thought that the Arabs having obtained the fruit in India probably introduced it into the Holy Land or northern Egypt where it seems to have been unknown before the Mohammedan conquest, A.D. 650. Peter Martyr, Spanish Ambassador to Venice and Egypt, in 1501 records plantains or bananas as a common food in Alexandria at the end of the fifteenth century.

It has been suggested that the plantain may have reached Equatorial Africa from Egypt through the Nile Valley. The Baganda have a tradition that the first plant was brought into the country by Kintu, who was the legendary ancestor of the Baganda, said to have come from the region of Mount Elgon. According to tradition this banana or plantain was planted at Magonga in Busuju County of Entebbe District and from it all the other varieties cultivated at the present day are derived. A partial survey in Uganda up to 1940 had resulted in fifty-one distinct forms being collected together, of which many are also grown in Tanganyika.

Of the numerous native varieties of banana and plantains tried at Amani from northern Tanganyika, there were very few bananas. Of the latter the best was from the Amani District and on inquiry it was said to have been introduced from Java at the beginning of this century.

(*To be continued*)

PINEAPPLE EXPERIMENT IN ZANZIBAR

Part II

By G. E. Tidbury, Agricultural Officer, Zanzibar

In a previous report* covering the first and second harvesting seasons, the results of a manurial and a spacing trial on pineapples, conducted at the Kizimbani Experiment Station, were described. The results of the third and fourth harvesting seasons of these trials are now available and the present article reviews the findings over the four-year period.

One of the aims of the experimental programme on pineapples being carried out at Kizimbani is to study methods whereby pineapples can be grown in continual cultivation on the same land. This kind of cultivation markedly influences experimental results from two main causes.

Firstly, the stimulating effect of a treatment which produced a heavy harvest is followed in the next year by an adverse effect in that more of the plants which received the treatment become "ratoons" than do those in the non-treated areas and the "ratoon" plants do not bear so well in the second year as original plants which have not yet fruited. Care must be taken therefore in distinguishing between a treatment effect which is merely hastening the harvest and the more valuable effect of both hastening and increasing the harvest.

The second cause is that yield apparently diminishes with continued ratooning, apart from the effects of soil exhaustion. The manner in which repeated cropping produces this result is not yet clearly understood, but the habit of growth of the plant may afford a tentative explanation. Each ratooning sucker becomes progressively further detached from the soil as suckers sprout from the axils of the parent plant and frequently become recumbent under the weight of their fruit. After a few years it becomes necessary to remove all the old root bases and reset the last generation of suckers firmly in the soil. This, apparently, has a stimulating effect on fruit (yield, number and total weight), although if the majority of suckers are replanted in the plot the effect may be similar to the establishment of a completely new block in which practically no fruit will be harvested for 18 months. Further experiments are in progress at Kizimbani to determine what is the most profitable number of ratoons that can be taken before replanting the suckers, but the general effect of continued ratooning is shown in the results of the experiments described in this article.

Throughout these experiments the yield of pineapples has always been assessed in three ways. The criteria are: firstly, the number of fruits per acre; secondly, the total weight of fruits per acre; and thirdly, the average weight of the single fruit. The size of the fruit is important because small fruits are useless in high-quality slice-canning.

The Manurial Experiment

The layout and treatments are described in detail in the previous article, but since the end of the second harvesting season the following modifications in the manurial dressings have been made. The original nitrogenous dressing of 250 lb. per acre per annum of sulphate of ammonia and also the original superphosphate dressing at the same rate have been doubled. The dressing of sulphate of potash at 200 lb. per acre per annum was also doubled for the third season, but then reduced to the original level owing to shortage of supplies. The results are detailed in the appendix.

Statistically significant results in the manurial experiment have been obtained only for the effects of sulphate of ammonia and sulphate of potash and for the interaction between them. The nitrogenous dressing in the first year caused increases of 706 pineapples per acre or 2.818 tons of fruit, equivalent to an increase of 0.899 lb. in the average weight of the fruits. In the second year similar increases accrued to the use of nitrogen, but owing to the adverse effect of ratooning plants referred to above, the increases were not so large for the first two criteria, namely 441 pineapples per acre and 2.114 tons per

* For Part I *see* this Journal, Vol. 8, No. 4, 80-84, October, 1942.

acre. In average size of fruits the increase due to nitrogen is more than before, namely 1.066 lb. This is noteworthy and is further shown in the third year's results.

The crippling effect of large numbers of ratooning plants in the nitrogen-treated plots compared with the other treatments is markedly shown in the third harvesting season, for the effects of nitrogen become negative for the first two criteria. Decreases of 414 pineapples per acre or 0.452 tons of fruit per acre are the mean effects. However, in terms of the average weight of fruit the effect of nitrogen is still positive and significant, namely an increase of 0.549 lb. per fruit. This apparently indicates that the physiological effect of nitrogen in producing large fruits is not seriously affected by continued ratooning as are the number and total weight of fruits per acre.

At the end of the third season the experimental plots showed the results of the double ratoon crop in that the field was very untidy with large numbers of old root bases, the new suckers being mostly recumbent and relying on adventitious roots for their attachment to the soil. The suckers were then firmly reset in the ground and the old root bases removed. This is presumed to have caused the nitrogenous dressing in the fourth harvest to bring about large positive effects again as in the first two years. These were increases of 735 pineapples per acre, 1.942 tons per acre and 0.718 lb. per fruit. Under the conditions of this experiment, therefore, great value derives from annually manuring pineapples with sulphate of ammonia.

Turning to sulphate of potash, the effect of its application seen in the first harvesting season is only statistically significant in terms of the number and total weight of fruit per acre. Potash caused mean decreases of 576 pineapples per acre and 1.594 tons of fruit per acre. The average weight of fruit was not significantly affected.

In the second and third harvests none of the effects of potash are significant, but in the fourth harvesting season significant mean effects are clearly shown and are positive. These represent increases of 268 pineapples per acre, 1.393 tons of fruit per acre and 0.925 lb. in the average weight of pineapples.

The potash results are most noteworthy and show that potash has evidently become more useful each year and is now apparently needed. Over the four years its gradually increasing effect is clearly shown thus:—

TABLE I

THE MEAN EFFECTS OF SULPHATE OF POTASH
(Statistically significant effects are in black figures)

	Season			
	First	Second	Third	Fourth
Number of fruits per acre ..	**—576**	—112	+112	**+268**
Total weight of fruit per acre (tons) ..	—1·594	—0·390	+0·558	+1·393
Avreage weight of fruit (lb.) ..	—0·208	—0·178	+0·322	+0·925

Evidently potash has an adverse effect if present in excess, but it is important that the supply should not become greatly diminished.

The interaction between sulphate of ammonia and sulphate of potash caused small and insignificant effects in the first three years, but in the fourth season positive and significant differential effects are shown equivalent to increases of 349 pineapples or 1.180 tons per acre and 0.487 lb. in the average weight. The effect of this interaction in the fourth harvesting season may be shown thus:—

TABLE II

NUMBER OF PINEAPPLES PER ACRE

	Mean responses	Differential responses			
		Nitrogen		Potash	
		Absent	Present	Absent	Present
Nitrogen ..	+735	—	—	+386	+ 1,084
Potash ..	+268	— 81	+617	—	—

TOTAL WEIGHT OF FRUIT PER ACRE (Tons)

	Mean responses	Differential responses			
		Nitrogen		Potash	
		Absent	Present	Absent	Present
Nitrogen ..	+1·942	—	—	+0·762	+3·122
Potash ..	+1·393	+0·213	+2·573	—	—

AVERAGE WEIGHT OF FRUIT (Lb.)

	Mean responses	Differential responses			
		Nitrogen		Potash	
		Absent	Present	Absent	Present
Nitrogen ..	+0·718	—	—	+0·231	+1·205
Potash ..	+0·925	+0·438	+1·412	—	—

It is thus clear that the potash applications are of value mainly when nitrogen is already present.

The responses to superphosphate throughout the experiment are small and insignificant and there is no indication up to the present that manuring with this fertilizer has any value under our conditions. The other interactions, namely those between nitrogen and phosphate, potash and phosphate and the triple interaction are so far all statistically insignificant and need not be considered in detail.

The Spacing Experiment

The layout of this experiment was also described in detail in the previous article, the three espacements under trial being equivalent to 5,808, 9,680 and 12,906 plants per acre. All plots have received equal dressings of artificials and since the end of the second season the nitrogen and phosphate dressings have been doubled. The results obtained in the third and fourth seasons are shown in the Appendix.

The results of the first two harvesting seasons showed that close spacing in the field caused large increases in the total weight and number of pineapples per acre but decreased the average weight of the individual fruits. The second season showed a marked drop in performance in every respect. This was most marked in the case of the closely spaced plots.

The third seasonal harvest showed that this deterioration continued except that the average size of fruits was somewhat better. The fourth harvest gave yields which were very much worse in all respects and clearly indicated that the third ratoon crop was hardly worth picking. Indeed when the numbers of pineapples large enough for slice-canning (approximately those of 4 lb. weight and over for the A 2½ standard size can) were estimated for the whole series of harvests the drop in performance over the four years is remarkable.

Table III

Numbers of Pineapples over 4 Lb. in Weight per Acre

(Figures approximate)

Espacement	Season				Total
	First	Second	Third	Fourth	
Close ..	4,460	1,100	2,350	172	8,082
Medium ..	3,120	1,610	1,880	143	6,753
Wide ..	2,610	1,370	685	78	4,743
Average ..	3,397	1,360	1,638	131	—

When comparing the performances of the different espacements in the third and fourth harvesting seasons the yields show that in terms of total number and total weight of fruit per acre the close and medium espacements are better than the wide. No significant differences are seen between the close and the medium espacements. The differences in the average size of the individual pineapples which were markedly in favour of wide spacing for the first two seasons were not maintained in the third and fourth harvests.

When the whole four years are reviewed it becomes evident that the close espacement gave the best results. This is to be seen in Table III where the approximate yields of fruit suitable for canning are given. However, the actual close spacing used in these experiments (bands of four rows 1 ft. 6 in. apart with plants 1 ft. 6 in. apart in the row, equivalent to 12,906 plants per acre) was found in practice rather too close for ease of working when cultivating, applying manures and harvesting. A slightly wider espacement is therefore recommended for plants grown under similar conditions.

Acknowledgment

Most of the officers of the Zanzibar Department of Agriculture have assisted at various times in the field work, recording and analysis of these experiments, and their work is gratefully acknowledged.

Summary and Conclusions

Manurial and spacing experiments with pineapples, which have been carried out for four years, indicate that, under Zanzibar conditions, dressings of sulphate of ammonia cause increases in the number and size of fruits produced. The effect of sulphate of ammonia on the number of fruits produced became negative for the second ratoon crop, but positive again after partial re-planting. Dressings of sulphate of potash which caused decreases in yield in the first year became of positive value and caused yield increases by the fourth year. These are greatest when nitrogen is also present.

Close spacing increases the total number and total weight of fruit reaped, but causes decreases in average size. Under conditions of continued ratooning, when some deterioration in all plots occurs, the differences in average size of fruit caused by differences in espacement are not maintained.

APPENDIX

THE MANURIAL EXPERIMENT (MAIN TREATMENT EFFECTS AND INTERACTIONS)

Third Canning Season: October, 1941 to March, 1942

Treatment	Number of fruits per acre	Total weight of fruit per acre	Average weight of fruit
		Tons	*Lb.*
N	— 414*	—0·452	0·549†
P	32	—0·048	—0·186
Interaction N×P ..	— 68	—0·370	—0·194
K	112	0·558	0·322
Interaction N×K ..	— 23	0·084	0·093
Interaction P×K ..	135	0·302	—0·036
Interaction N×P×K	54	0·142	0·050
S.E.	± 147·2	± 0·483	±0·206

Fourth Canning Season: October, 1942 to March, 1943

Treatment	Number of fruits per acre	Total weight of fruit per acre	Average weight of fruit
		Tons	*Lb.*
N	735*	1·942*	0·718*
P	69	—0·017	—0·128
Interaction N×P ..	— 146	—0·303	—0·056
K	268†	1·393*	0·925*
Interaction N×K ..	349*	1·180*	0·487*
Interaction P×K ..	61	0·270	0·182
Interaction N×P×K	— 110	—0·144	—0·006
S.E.	± 124·3	± 0·307	± 0·145

THE SPACING EXPERIMENT (TREATMENT YIELDS)

Third Canning Season: October, 1941 to March, 1942

Espacement	Number of fruits per acre	Total weight of fruit per acre	Average weight of fruit
		Tons	*Lb.*
Wide	857	2·044	5·24
Medium	2·325	5·780	5·30
Close	3·162	7·056	4·88
Difference required for 5 per cent significance	975	2·396	Insignificant

Fourth Canning Season: October, 1942 to March, 1943

Espacement	Number of fruits per acre	Total weight of fruit per acre	Average weight of fruit
		Tons	*Lb.*
Wide	779	1·015	2·93
Medium	1·434	1·759	2·68
Close	1·724	2·246	2·76
Difference required for 5 per cent significance	609	0·857	Insignificant

*Represents significance of P=0·01

†Represents significance of P=0·05

NOTE ON THE CONTROL OF THE ROOT KNOT EELWORM

The root knot eelworm, *Heterodera marioni* is, in warm countries, one of the most difficult pests to keep in check. At one time apparently confined to horticultural crops and doing most harm in intensively cultivated gardens, it has now, in Kenya, been found attacking field crops such as potatoes and pyrethrum. The direct control measures by means of chemicals and heat have no practical application except in glass house practice. Generally, the grower has no alternative but to endeavour to keep down the numbers of nematodes by means of long rotations between susceptible crops. With the very wide range of host plants, this is by no means easy and amounts to either long bare fallows with frequent cultivation, putting down to grass or growing cereals, maize or a crop like Napier grass. None of these is likely to appeal to the gardener or orchardist, many of whose crops are perennial and whose system of cultivation is intensive.

During recent years attention has been given to the inhibiting effect on the nematodes of increasing the organic matter content of the soil. Successful trials in this respect have been reported from India and elsewhere.

At the Scott Laboratories, a house used for the growing of stock seed potatoes was found to have become infested with eelworm and a large proportion of tubers lifted in 1941 showed varying degrees of infection.

In July, 1942, a very heavy application of chopped Napier grass was added to the soil. The Napier grass had been put through a chaff cutter, producing pieces of leaf and of split stem about two inches long. In order to get such bulky material into the soil, a trench 12-18 inches deep was filled with the cuttings. This was then covered with soil from the next trench and so on. The beds were then lightly stirred with a fork to obtain as good a mixture as possible. The whole was kept moist until planted the following May. At this time some consolidation was necessary and much of the added material was undecomposed. The plants were sickly and chlorotic and produced few tubers. None of these showed any signs of eelworm attack.

The house was again planted in September, 1943. By this time, the Napier grass was completely decomposed. The plants grew well and a normal crop was lifted in January, 1944. No eelworm lesions appeared on any of the tubers.

This trial was not, of course, done as a scientific experiment. The procedure was adopted as a matter of expediency. It does, however, serve as a pointer and one more indication of the lines to be followed in combating a pest which is becoming an increasing menace to crop production.

R. M. NATTRASS.

OX TREK GEAR

By L. A. Elmer, Assistant Agricultural Officer, Department of Agriculture, Kenya

In this article I have to acknowledge gratefully the advice of E. H. de Waal, Esq., J.P., Chairman of the Elgeyo Border Production Sub-committee, Eldoret.

The best way to keep trek gear in good order is to have it laid out once a week for inspection. Every yoke, tie, chain, reim, skey, strop and whip should be put down in proper order. The driver and his assistants stand by the gear for which he is responsible.

The head driver should look after wagon jacks, spanners, oil cans, grease tins and such simple remedies as may be kept on a shelf in the trek gear store. This should not be the main store as, if the master is away, or his *neopara*, the head driver may not be able to administer a dose to a suffering beast at the right time.

A complete set of spanners and tools for the implements and vehicles should be available in a lock-up harness store and should not be borrowed by anyone else, unless application is made to the head driver, who cannot be held responsible if all and sundry can get into his store.

Reims.—A reim about about 8 feet long is needed for each ox. One of my earliest recollections of East Africa is an old South African who was good enough to teach me how to brey a hide. He showed me a bundle of wide soft reims made in South Africa and brought here some years before. If they got wetted they were breyed or worked by hand as they were drying in order to keep them soft. This is mentioned to show that reims can be made to last years. As a rule on the average farm reims last a very short time. They are cut too narrow and are not breyed enough, drivers pare off thin strips from them for whip lashes. Natives steal them to make beds or to sell them, etc., but regular inspections considerably reduce the annual loss of reims. Many farmers give up the struggle and allow only the leading yoke a pair of reims. On the highways, however, every beast should have a reim. If the wagon has to stop by night it may be necessary to tie each animal to prevent them straying. A reim prevents an ox from breaking loose and being a danger on the road. Reims are useful for tying on loads or doing emergency repairs, so that a team should go out with a full complement and a couple of spares. The best reims are from water-buck hides, as these do not take in water readily.

Strops.—Strops should be soft as the edges of hard raw hide will cut the ox. Pieces of old soft reims which break should be saved for making strops and be issued to the drivers for that purpose. The strops thus made are issued to the head driver to give him spares for each team. His new issues should be against broken remnants for replacement on inspection day.

Ties.—The tie has a harder life than reim or strop. Some people use a metal U shackle instead of a tie to join the ring of the chain and the staple of the yoke, but this is not recommended as the staples wear out quickly.

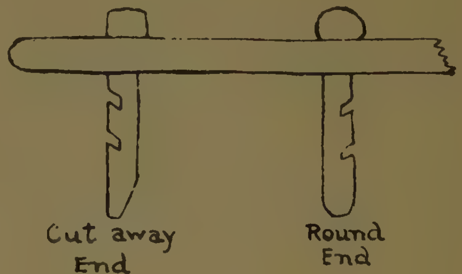
Reims used for ties should be long enough to allow for several turns. They should be soft to make adjustments easy and to give an even strain on all the loops or turns.

It lengthens the life of a tie to undo it occasionally to change the places where wear is taking place against the metal and to grease and work it to keep it pliable.

A common mistake is to have ties too short. A fairly long tie allows an ox to side-step to avoid a boulder, stump or hole (and, of course, to make his partner side-step with him). If the tie is too short he cannot do this as he has no play.

Skeys.—There should be no points about a skey to hurt an ox. A square-bottomed skey will cut into the shoulder of an ox as he moves sideways and, at the end of a day or two of rough work, a sore place may be caused. Permissible shapes are as shown in Fig. 1.

FIG. 1



The notches in the skeys should be made as in Fig. 1. A common fault with home-made skeys is a triangular notch cut with a *panga* from which the strop is liable to slip. The notches should be made with a saw and the edges of the cuts rasped smooth with a wood

rasp to allow the loops of the strop to be slipped on and off easily. The skey should fit well in the yoke but should not stick. Many farmers make their drivers cut a skey daily so that there are always plenty in stock

Yokes.—Many of the yokes one sees are rather short, about 5 feet long; 5 feet 6 inches would be better. It is easier pulling for the oxen and keeps them well away from the chain if the yoke is full length. The leverage of one ox against the other is easier and thus the performance of the same amount of work becomes easier.

Rear yokes, particularly on wagons, should have two staples pointing downward at 45° to the rear, see Fig. 2. The reason for the required angle of 45° the strain on the oxen is lessened and the steering of the wagon becomes lighter.

The reason for having two staples in the rear yoke is to help the oxen to steer. A reference to Fig. 4 will make the following explanation intelligible: If the wagon has to go to the right, ox A pushes over to the right and with two staples in the yoke he puts pressure on to the staple "b" and hence on to the pole more quickly than if there was only a single tie from one staple in the middle.

The lead oxen of a team should also have a double-stapled yoke, but the angle of these staples is the same as for the ordinary yoke, viz. at right angles to the skey. (Fig. 3.)

FIG 2.

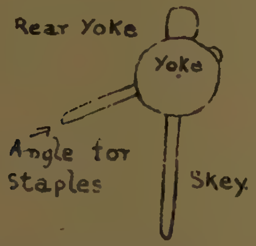
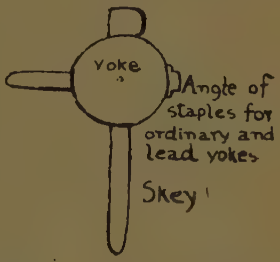


FIG 3.



angle of 45° is that the pull on the rear yoke is at an angle to the chain or pole, which makes the arrangement the easier for the wheelers. When going downhill the forward thrust of the wagon pole pushes the yoke staples down and forward and brings the bottom ends of the skeys to the front. If the staples are fastened into the yoke at the

The reason for two staples in the leading yoke is that one hardly ever gets two oxen of exactly the same strength suitable for lead work, and by adjusting the length of the ties one can allow for the difference in strength and give the two beasts a straight pull on the yoke instead of a tendency for each to pull partly against the skey—see Fig. 5.

FIG. 4 Rear Yoke

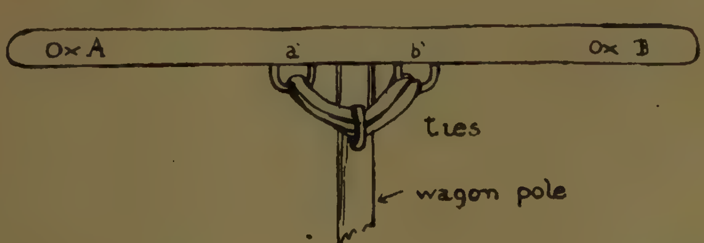
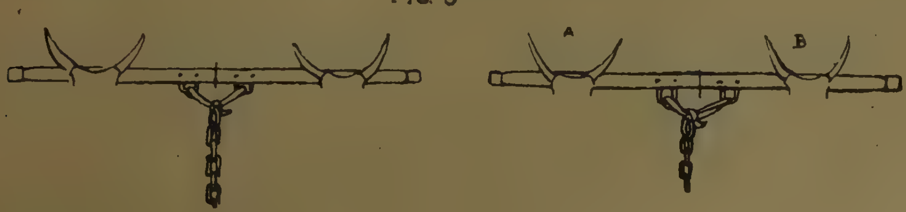


FIG. 5



The longer tie gives the weaker ox B greater leverage than Ox A, and with little adjustment both animals will go ahead together with the yoke at right angles to the chain.

Chains.—A heavy chain should not be used where a light one will do equally well. A chain is a heavy thing to carry about.

The best set of chains for a span doing normal farm work is either $3\frac{3}{8}$ in. in front, $3\frac{7}{16}$ in. in the middle and $2\frac{1}{2}$ in. in the rear or $3\frac{3}{8}$ in. in front and $5\frac{1}{2}$ in. in rear.

Chains should be of the right length for the animals, i.e. there should be a decent interval of about 2 feet between the tail of one ox and the muzzle of the ox behind him. If the chains are too long the oxen will get over them and may even break a leg; at any rate a delay is caused.

If the chains are too short the oxen will not be able to pull properly as they will not be able to see where they are going and will not pull all out if they think they are going to run into the animals in front of them.

Whips.—Any self-respecting driver will want as good a whip as he sees the other drivers have about the district, and a wise farmer will see that he gets it.

The best thongs are of giraffe, hippo or rhino. The best lashes from bush-buck, topi or impala. Having received a good whip the driver must look after it!

CORRESPONDENCE

Somaliland Protectorate, Burao,
31st January, 1944.

The Editor, East African Agricultural Journal.

Dear Sir,

Air travel as a means of studying vegetation has its very definite limits and its deceptions; but so also, and perhaps in even greater degree, has travel along roads, because roads are always made with a view to avoiding nullahs and eroded areas.

Some months ago I flew across the Horn of Africa from Jigjiga to Mogadiscio and thence via Lugh Ferandi to Nairobi. This vast stretch of country, much of which I had seen from the road, is eroding. The picture is one of a complete drainage system which removes the rain water over the soft earth as rapidly as possible; it is so right to the gates of Nairobi.

Large swarms of locusts have recently been seen in this area, and the whole resources of the community, backed with Imperial funds, have been put to fight them regardless of expense. Locust damage in comparison with erosion damage of the kind which is now occurring is but transitory and slight, and it is even beneficial because in the long run it probably damages stock more than vegetation and thus tends to maintain the animal–vegetable equilibrium. It seems to me essential that this whole area, and indeed most of the area surrounding the Abyssinian highlands, should be brought under an East African technical-political anti-erosion control similar in scope to the proposed East African Anti-Locust Directorate. This erosion Directorate would seek to conserve and create pasture and by all known means, such as by the control of grazing, by the provision of markets for stock, and by the improvement of internal markets for both imports and exports; it would thus try to prevent the formation of desert.

It is said that this part of Africa is being desiccated through natural causes; and it is therefore all the more important to preserve such pasture as now exists.

I believe that when the reasons for this colossal damage are determined it will be found that the detribalization of grazing areas, which has been caused by the European insistence that tribes should not be able to protect their own grazings, will be seen to be the primary cause of this desiccation. This disease of the soil, and from the air it resembles nothing more than a skin disease, calls for early investigation and action to prevent the inevitable natural drive of the hardy inhabitants of these areas into Kenya and southwards.

In my own lifetime I have seen, and have helped to create, the formation of a desert in Alberta and Saskatchewan, and have witnessed the abandonment of, and migration from, huge areas by man in these Provinces; I have witnessed the Sahara in Northern Nigeria; and now the unmistakable signs of desert formation are here, and, as always, man's reaction is indifference bred of familiarity until the time comes when he finds himself foodless.

Yours faithfully,
EDWARD F. PECK.

[While we can support Capt. Peck in his plea for a central body for the co-ordination of soil conservation measures, we cannot agree with him that locust damage is "transitory", "slight" and "even beneficial". Locusts accentuate the erosion problem caused by overgrazing in that they destroy what little grass is left, after the cattle have done their worst, so that the soil is liable to wind erosion, as well as accelerated erosion by water.

Again, the funds spent on anti-locust measures are intended to protect, not only the areas where they are spent, but also the highly cultivated areas to which the locusts, if left, might migrate.—*Ed.*]

SUPPLEMENT TO THE REVISED LIST OF PLANT DISEASES IN TANGANYIKA TERRITORY

By G. B. Wallace and M. M. Wallace, Department of Agriculture, Tanganyika Territory

Since the earlier revised list of plant diseases in Tanganyika Territory was published in this Journal in January, 1937, further records have been made and are listed below. These diseases vary greatly in their importance: most of the identifications have been confirmed by the Imperial Mycological Institute, Kew, and other authorities. The present list includes a small number of fungi recorded on non-economic plants; the majority of the smuts on wild grasses were collected by the late Mr. A. H. Ritchie, and listed by G. L. I. Zundel (The Ustilaginales of South Africa, *Bothalia* 3 (3), 1938).

Albizzia sp.
  Leaf-spot, *Endodothella deightonii* Syd.

Amaranthus spp. ("Mchicha")
  White blister, *Cystopus Bliti* de Bary

Apple (*Pyrus malus* Linn.)
  Pink disease, *Corticium salmonicolor* Berk. and Br.

Avocado (*Persea americana* Mill.)
  Soft rot of fruit, *Gloeosporium cingulatum* Atk. (*Glomarella cingulata* (Stonem.) Spauld. and von Schrenk)

Banana (*Musa sapientum* Linn.)
  Cercospora leaf-spot, *Cercospora musae* Zimmerm.
  Cigar end rot, *Stachylidium theobromae* Turconi
  Stem and root rot, *Marasmius semiustus* Berk. and Curt.

Baobab (*Adansonia digitata* Linn.)
  Mildew, *Oidiopsis taurica* (Lév.) Salmon

Beans
  Lima bean (*Phaseolus lunatus* Linn.)
    Pod and seed rot, *Rhizoctonia solani* Kühn (race of).
  French bean (*Phaseolus vulgaris* Linn.)
    Burst seed skins, physiological; cotyledons protrude from seed coat
    Common mosaic, a virus disease.
    Halo blight, *Pseudomonas medicaginis* var. *phaseolicola* (Burk.) Dowson
    Leaf-spot, *Mycosphaerella ?pinodes* (Berk. and Blox.) Vestergr., and its conidial stage *Ascochyta ?pinodes* L. K. Jones, with *Epicoccum* sp. present but saprophytic.
    Sclerotinia disease, *Sclerotinia sclerotiorum* (Lib.) de Bary
    White mould, *Hyalodendron* (*Cladosporium*) *album* (Dowson) Diddens, conidial stage of *Erostrotheca multiformis* Mart. and Charles
    Yeast spot, *Nematospora coryli* Pegl.
    Yellow mosaic, a virus disease.
    Yellowing, physiological; on a waterproof clay soil with poor drainage and aeration.

Beetroot (*Beta vulgaris* Linn.)
  Leaf-spot, *cercospora beticola* Sacc.

Bidens pilosa Linn. (Black-jack)
  Smut, *Entyloma bidentis* P. Henn.

Cabbage (*Brassica oleracea* Linn.)
  Black rot, *Xanthomonas campestris* (Pamm.) Dowson

Carrot (*Daucus carota* Linn.)
  Leaf blight, *Alternaria macrospora* (group)

Cauliflower (*Brassica oleracea* var. *botrytis* Linn.)
  Black rot, *Xanthomonas campestris* (Pamm.) Dowson

Celery (*Apium graveolens* Linn.)
  Late blight, *Septoria apii-graveolentis* Dorogin

Chenopodium sp.
  Downy mildew, *Peronospora effusa* (Grev.) Tul.

Chick pea (*Cicer arietinum* Linn.)
    Blight, *Ascochyta rabiei* (Pass.) Lab., conidial stage of *Mycosphaerella rabiei* Kovacevski

Chilli Pepper (*Capsicum annuum* Linn.)
  Mildew, *Oidiopsis taurica* (Lév.) Salmon
  On leaves, *Cercospora capsici* Heald and Wolf

Chinese cabbage (*Brassica chinensis* Linn.)
  Leaf-spot, *Cercospora brassicicola* P. Henn.

Chrysanthemum sp.
  Leaf-spot, *Septoria chrysanthemella* Sacc.
  Rust, *Puccinia chrysanthemi* Roze; uredosori only

Citrus
  Orange (*Citrus aurantium* Linn.)
    Ring blotch, cause unknown.
    Anthracnose of fruit, *Colletotrichum gloeosporioides* (Penz.) Sacc.

Coffee (*Coffea arabica* Linn.)
  Damping-off of seedlings and cuttings in frames, *Rhizoctonia* sp.

Stem and branch cankering, physiological; poor planting and cultural conditions

Yellowing, physiological; on a waterproof clay soil with poor drainage and aeration; causes many deaths

Cordia holstii Gürke
Leaf-spot, *Phyllachora caffra* Syd.
Mildew, *Oidium* sp.

Cotton (*Gossypium hirsutum* Linn.)
On bolls, *Rhizopus nigricans* Ehrenb., probably secondary

Cowpea (*Vigna unguiculata* Walp.)
Mildew, *Erysiphe polygoni* DC.
Mosaic, a virus disease

Crucifers
White blister, *Cystopus candidus* (Pers. ex Chev.) Lév.

Cucumber (*Cucumis sativus* Linn.)
Downy mildew, *Pseudoperonospora cubensis* (Berk. and Curt.) Rostowz

Leaf-spot, *Cercospora cucurbitae* Ell. and Everh.

Dahlia
Sclerotinia disease, *S. sclerotiorum* (Lib.) de Bary
Mildew, *Oidium* sp.
Mosaic, a virus disease

Egg Plant (*Solanum melongena* Linn.)
Fruit rots, *Phomopsis vexans* (Sacc. and Syd.) Harter, conidial stage of *Diaporthe vexans* (Sacc. and Syd.) Gratz; and *Phytophthora* sp.

Eschscholtzia sp.
Sclerotinia disease, *S. sclerotiorum* (Lib.) de Bary

Garlic (*Allium sativum* Linn.)
Purple blotch, *Alternaria porri* (Ell.) Neergaard
Rust, *Puccinia allii* (DC.) Rud.

Gladiolus sp., cult.
Rust, *Uromyces transversalis* (Thuem.) Wint.

Gram, black (*Phaseolus mungo* Linn.)
Leaf-spot, *Myrothecium roridum* Tode ex Fries
Mildew, *Erysiphe polygoni* DC.

Gram, green (*Phaseolus aureus* Roxb.)
Leaf-spot, *Cercospora* sp.
Rust, *Uromyces appendiculatus* (Pers.) Link

Grape Vine (*Vitis vinifera* Linn.)
Anthracnose, *Gloeosporium ampelophagum* Sacc. (*Elsinoë ampelina* (de Bary) Shear)

On stems, *Monochaeta* sp., very close to *M. ampelophila* Speg.

Grasses
Guinea grass (*Panicum maximum* Jacq.)
Leaf-spot, *Phyllachora heterospora* P. Henn., with *Coniothyrium occultum* Syd. parasitic in the stromata.

Rust, *Puccinia cameliae* Arth.

Smut, *Tilletia ayresii* Berk. ex Massee

Johnson grass (*Sorghum halepense* Pers.)
Smut, *Sphacelotheca cruenta* (Kühn) Potter

Napier fodder (*Pennisetum purpureum* Schum.)

False mildew, *Beniowskia penniseti* (Kalchbr. and Cooke) Mason, overgrown with *Constantinella* sp.

Leaf-spot, *Piricularia grisea* Sacc. f.

Sorghum verticilliflorum Stapf
Smut, *Sorosporium ?simii* P. Henn. and Pole Evans

Sorghum vulgare Pers. var. *caffrorum* (Thun.) Hubbard and Rehder
Smuts, *Sphacelotheca holci* H. S. Jackson, and *Sorosporium reilianum* (Kuhn) McAlpine

Andropogon sp.
Smut, *Sphacelotheca stuhlmanni* (P. Henn.) Zundel

Cymbopogon schoenanthus Spreng.
Smut, *Sphacelotheca milbraedii* (H. and P. Sydow) Zundel

Cynodon dactylon Pers.
Smut, *Ustilago* sp.

Digitaria sp.
Streak disease, virus

Eragrostis sp.
Streak disease, virus

Heteropogon hirtus Pers.
Smut, *Sphacelotheca columellifera* (Tul.) Cifferi

Heteropogon contortus (Linn.) Roem. and Schultz
Smut, *Sphacelotheca monilifera* (Ell. and Ev.) Clinton

Hyparrhenia cymbaria Stapf
Smut, *Sphacelotheca ritchiei* Zundel

Hyparrhenia rufa Stapf
Smut, *Sorosporium zundelianum* Ciferri

Hyparrhenia tamba Anderss.
Smut, *Sorosporium maranguense* P. Henn.

Hyparrhenia sp.
Smut, *Sphacelotheca* sp. near *S. cruenta* (Kuhn) Potter

Rottboellia exaltata Linn.
Smut, *Sphacelotheca flagellata* (Sydow) Zundel
Streak disease, virus

Setaria chevalieri Stapf
False smut, *Ustilaginoidea ?ochracea*

Setaria pallida-fusca Stapf and Hubbard
Smut, *Ustilago evansii* P. Henn.

Themeda Triandra Forsk.
Smut, *Sorosporium holstii* P. Henn.

Larkspur (*Delphinium* sp.)
Root rot, *Sclerotium* sp.
Mildew, *Erysiphe polygoni* DC.

Leek (*Allium porrum* Linn.)
Rust, *Puccinia allii* (DC.) Rud.

Lovage (*Levisticum officinale* Koch)
Mildew, *Erysiphe polygoni* D.C.

Lucerne (*Medicago sativa* Linn.)
Leaf-spot, *Pseudopeziza medicaginis* (Lib.) Sacc.
Rust, *Uromyces striatus* Schroet.

Mango (*Mangifera indica* Linn.)
Bacterial black spot, *Bacterium mangiferae* (Doidge) Burgwitz
Mildew, *Erysiphe cichoracearum* DC.

Nasturtium (*Tropaeolum majus* Linn.)
Sclerotinia disease, *S. sclerotiorum* (Lib.) de Bary
Leaf-spot, *Pleospora tropaeoli* Halst.

Ocimum gratissimum Linn. var *suave*
Rust, *Puccinia ocimi* E. M. Doidge

Okra (*Hibiscus esculentus* Linn.)
Leaf-spot, *Cercospora hibisci* Tracey and Earle

Onion (*Allium cepa* Linn.)
Bulb disease, *Sclerotium rolfsii* Sacc.
Purple blotch, *Alternaria porri* (Ell.) Neergaard
Rust, *Puccinia allii* (DC.) Rud.

Papaw (*Carica papaya* Linn.)
Rot of root, stem, fruit and petioles, Pythiaceous fungus

Parsley (*Petroselinum hortense* Hoffm.)
Leaf-spot *Septoria petroselini* Desm.

Pea (*Pisum sativum* Linn.)
Leaf-spot, *Ascochyta pisi* Lib.

Petunia sp.
Mildew, *Oidium* sp. (*Erysiphe cichoracearum* DC.)

Plum (*Prunus domestica* Linn.)
Root disease, *Ustulina zonata* Lév.

Poppy (*Papaver* sp.)
Mildew, *Oidium* sp.

Portulacca spp.
White blister, *Cystopus portulaccae* (DC.) Lév.

Potato (*Solanum tuberosum* Linn.)
Black dot, *Colletotrichum atramentarium* (Berk. and Br.) Taubenh.
Black scurf, *Rhizoctonia solani* Kühn, (*Corticium solani* Bourd. and Galz.)
Common scab, *Actinomyces scabies* (Thaxt.) Güss.
Internal brown fleck, physiological
Late or Irish blight, *Phytophthora infestans* (Mont.) de Bary
Sclerotinia disease, *S. sclerotiorum* (Lib.) de Bary
Sclerotium wilt, *Sclerotium rolfsii* Sacc.

Pumpkin (*Cucurbita pepo* Linn.)
Anthracnose, *Colletotrichum lagenarium* (Pass.) Ell. and Halsted
Mildew, *Erysiphe cichoracearum* DC.

Rose (*Rosa* sp.)
Black spot, *Diplocarpon rosae* Wolf

Sugar Cane (*Saccharum officinarum* Linn.)
Red leaf-spot, *Eriosphaeria sacchari* (v. Breda) Went.

Sunflower (*Helianthus annus* Linn.)
Rust, *Puccinia helianthi* Schw.
Sclerotinia disease, *S. sclerotiorum* (Lib.) de Bary

Sweet Pea (*Lathyrus odoratus* Linn.)
Mildew, *Erysiphe polygoni* DC.

Tea (*Thea sinensis* Linn.)
Root disease, *Rosellinia* sp.
Scab, *Elsinoë theae* Bitancourt and Jenkins

Tomato (*Lycopersicum esculentum* Mill.)
Blossom end rot, physiological
Fruit spot, *Colletotrichum phomoides* (Sacc.) Chester
Leaf mould, *Cladosporium fulvum* Cooke
Sclerotinia disease, *S. sclerotiorum* (Lib.) de Bary

Turnip (*Brassica rapa* Linn.)
Mildew, *Erysiphe polygoni* DC.

Valerian (*Valeriana officinalis* Linn.)
Leaf-spot associated with *Myrothecium roridum* Tode ex Fries
Violet (*Viola odorata* Linn.)
Leaf-spot associated with *Myrothecium roridum* Tode ex Fries

Yam (*Dioscorea* sp.)
Leaf-spot, *Cercospora carbonacea* Miles

Hosts of *Armillaria mellea* (Vahl.) Quél., add—
Bauhinia sp.
Oyster nut (*Telfairia pedata* Hook.)

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AN INEXPENSIVE FARM GATE

By J. K. Robertson, B.Sc. (Agr.), A.I.C.T.A.

Articles on farm fencing [1] which have appeared in this *Journal* have given little attention to farm gates and in particular to the type of gate that can be made easily and cheaply from materials available on the farm itself. An article on dairy farming [2] gives a description of the sliding type of gate, although no mention is made of its performance in actual use.

Experience of one farm-made gate over many years has shown it to be entirely satisfactory. This type consists of at least three horizontal poles joined together at either end by lengths of chain.* The poles should be of a heavy rather than a light wood, the thicker and heavier ends being towards the hinged or fixed end of the gate. The poles should be slightly longer than the gate opening to prevent stock passing between gate and gate-posts—a suitable length for poles being the width of the gate opening plus the thickness of both gate-posts; naturally, the gate opens *inwards* into a field.

The chains can be obtained from odd lengths of used chain commonly found on a farm, e.g. cattle binding chains, trek chains and even used car chains, care being taken to examine individual links and to discard those badly worn. Lengths of chain can be joined by means of "split" links or "repair" links, the open ends of which are hammered down to form a perfectly durable link. These repair links can be made on the farm or purchased cheaply from a blacksmith and are more satisfactory than joining chains with fencing wire. Lengths cut from mild steel rods can also be cold-hammered to give satisfactory repair links.

These chains should be passed round each pole and fixed by wire staples passed through a link and hammered into the wood. Mere fixing of a length of chain to the poles without passing the chain round each is unsatisfactory since the staple may pull out of the wood on account of the weight of the pole. At the hinged or fixed end of the gate the chain is firmly secured to the top of the gate-post, using an iron staple of ample size; the lower end of this chain can be fixed to the base of the gate-post, although the weight of the poles is sufficient to prevent stock lifting it. At the other, i.e. the opening end the gate is fastened by hooking the end of the second chain over a large nail or hook in the top of the gate-post.

In the case of smaller animals (sheep, etc.), that often escape below a fence or gate, this type of gate can still be used provided an additional pole—a fairly heavy one—is fixed to the chains at ground level. A length of wire-netting is added with the lower end fixed to the pole on the ground. Woven wire fence netting (usually known as "pig-netting") is much stronger than wire-netting and makes a more durable job. With these additions the gate is made proof against all farm animals, large and small.

The fact that this type of gate can be made quickly and cheaply from materials available on the farm is sufficient reason for it to be more widely used. The competent farmer will always have a stock of the essential parts, so that new gates can be quickly made or old gates repaired. As the gate can be made much longer than the conventional joiner-made article without loss of strength or undue increase in weight, it is most useful where large numbers of stock are handled.

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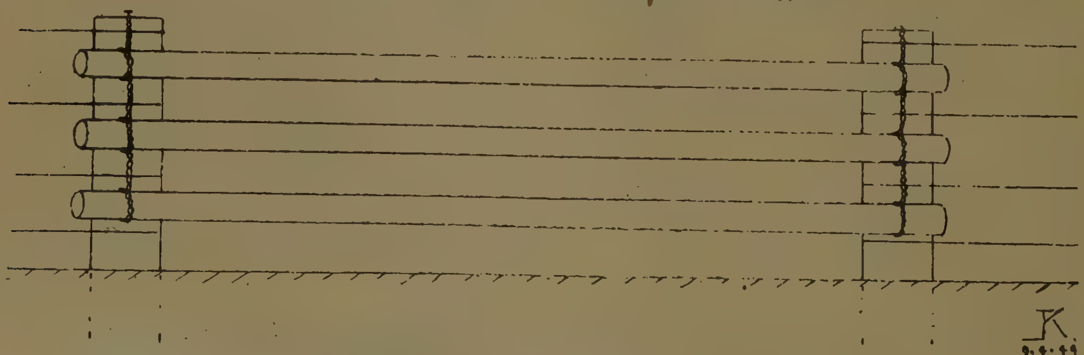
(1) Elmer, L. A.—Farm fencing. *East African Agricultural Journal*, III, 2-6, 1937-38.

(2) Whetham, S. D.—Management of the Dairy Herd on an Arable Farm. *East African Agricultural Journal*, IV, 6, May, 1939.



* We have seen twisted bull-wire used for this purpose in South Africa.—Ed.

NOTES ON ANIMAL DISEASES

XXIII—DEFICIENCY DISEASES

By J. R. Hudson, B.Sc., M.R.C.V.S., Veterinary Research Laboratory, Kabete, Kenya

During the present century a vast amount of time has been devoted to the study of the elements and accessory food factors which are necessary for the maintenance of health in man, animals and plants. Strictly speaking, starvation is a deficiency disease; but it is usual to restrict the term to conditions caused by the lack of some essential substance which is required in relatively small quantity only and to eliminate the results of what may probably be more correctly termed "improper feeding".

The list of minerals, that in small quantities have been found necessary for life, is considerable and continues to grow as various obscure diseases are elucidated. As to the accessory food factors or vitamins, only the more specialized workers can find time to digest the large amount of literature which is now published about them annually.

Mineral Deficiencies

In Africa, as in many other parts of the world, there are certain patches of soil which are eaten by domesticated stock and wild ruminants. Access to these natural salt-licks is regarded by the local native as essential to the well-being of his stock, and the writer knows of several to which at certain seasons of the year great numbers of wild animals flock for many miles.

With the notable exception of two samples received from the Chelbi Desert in the Northern Frontier District, which contained 15.13 per cent and 78.14 per cent of sodium chloride on a dry matter basis, the author has found that salt-licks do not contain sufficient salt to justify the theory that animals eat the licks for the salt they contain. As a rule, moreover, the lime and phosphoric acid contents are also too small to be of much value to the animal. Although it has been assumed that certain natural licks do contain soda, lime, iron or other compounds of use to stock, the reason why the majority of them are so attractive is still a mystery as the following analyses of licks from widely-separated areas will show:—

	Emali	Koru
Dry matter	100	100
Total inorganic matter	98·57	96·75
Inorganic matter soluble in 0·125 *N* HCl	1·77	6·56
Lime (CaO)	0·033	0·844
Magnesia (MgO)	0·402	0·140
Soda (Na_2O)	0·023	0·133
Potash	Nil	Trace
Phosphate (P_2O_5)	Trace	0·013
Chloride	Nil	Nil
Iron oxide (Fe_2O_3)	0·040	0·176
Alumina (Al_2O_3)	0·195	0·133
Copper oxide (CuO)	0·0008	0·001
Arsenic	Faint trace	Trace

Note.—0·125 *N* HCl is approximately equivalent in strength to the secretion of the ruminant stomach.

Since both these specimens were of licks eagerly eaten by cattle, one must presume either that they contain an element essential to the stock and for which search was not made, or that stock eat these licks for some reason other than their value as a source of minerals. It has been suggested that gastric irritation will cause animals to eat earth, and the fact that cattle will eat mineral matter from which they can assimilate nothing is confirmed by the frequent finding of quantities of obsidian in the abomasum of cattle in the Naivasha district. The tendency to eat earth is increased markedly in animals suffering from "fly".

That stock will usually benefit from a proper salt-lick is beyond question and, because they can obtain no reasonable quantity of either salt, lime or phosphates from natural licks, it is advisable to supply these as an artificial lick.

Experiments carried out by the Rowett Research Institute in 1927-29 showed that the provision of a mineral supplement to milk cows at Molo resulted in a considerable increase in milk yield and in the production of heavier calves. The cows receiving minerals had better condition and appearance than the controls, the difference being accentuated in the dry periods. In a similar experiment at Naivasha on better grazing, there was no apparent difference between the groups. Experiments on sheep showed that at Molo a mineral supplement led to better growth of the

sheep and better wool. The sheep also appeared to have an increased resistance to parasitic worms. At Naivasha, although the body growth was not affected, sheep receiving minerals produced more wool consistently over the three years of the experiment.

As a general rule it is recommended that a lick consisting of two parts of bonemeal, to provide lime and phosphoric acid, and one part of salt be placed so that stock may have access to it once a day. Although cattle may consume relatively large quantities when the lick is first offered, the quantity consumed per head per day will eventually become somewhat under 4 ounces. By casting the lick into bricks, wastage through spilling can be avoided, but the consumption may be reduced to below the optimum amount.

In East Africa ruminant stock suffer from a deficiency of cobalt which causes enzootic marasmus in parts of the Rift Valley; an incorrect lime/phosphoric acid ratio is responsible for osteodystrophia in horses; deficiency of iron and copper has been found responsible for anaemia in sucking pigs; and lack of salt produces a dermatitis and other lesions in camels. In addition rickets has been observed, on one occasion only in lambs on the Kinangop, and there is some evidence that a deficiency of iron and copper may be responsible for sweating sickness and still-born calves on one farm in Kenya. A peculiar disease of cattle in which deformation of the legs occurs has been seen on a farm in the Nanyuki district; but it is not known whether this condition is due to a deficiency.

Enzootic Marasmus, or what is usually known by the clumsy name "nakuruitis", occurs on two areas of volcanic soil, the one situated to the north-west of Lake Nakuru and the other between Mount Longonot and Lake Naivasha and to the south-east of this lake. Clinically the condition is indistinguishable from enzootic marasmus as it occurs in certain parts of Western Australia and experiments have proved conclusively that it can be controlled by the administration of minute amounts of a cobalt salt. It would appear, however, that deficiency of cobalt is not so extreme as it is in some areas of Australia and New Zealand.

As seen in Kenya the disease is somewhat seasonal in occurrence; cattle, in particular, are more prone to develop severe symptoms after the rains when grazing is plentiful and green.

The disease affects cattle and sheep but not horses. In cattle pronounced symptoms are more commonly seen in work-oxen and cows-in-milk than in other classes of stock, and in sheep, weaners and nursing ewes are most severely affected. Early cases show loss of condition and anaemia. Loss of condition may be slow, but in many cases is relatively rapid. It is not uncommon, for example, for a cow calving at a time suitable for the development of the disease, to become a "bag of bones" in as short a period as a fortnight. According to the Masai, who know the disease as "*narurasha*", in-calf animals may abort; but no abortions which have not been attributable to contagious abortion have been seen on European farms. In the final stages the animal refuses food, is "tucked up" and shows some evidence of abdominal pain. The coat is rough; but as a rule there is no rise in temperature. On post-mortem examination the animal rarely shows any characteristic lesions other than emaciation and anaemia. There may be a gelatinous infiltration of the throat or the wall of the fourth stomach and, on section, the spleen may show yellow-brown pigmentation of the fibrous tissue.

It has been known for many years that "nakuruitis" can be cured by moving cattle from the affected areas to healthy country. Experiments carried out by the Rowett Institute in 1926 suggested that the disease might be an iron deficiency, but later work by the author and D. H. McCalman have proved that the deficiency is of cobalt. Cobalt is an impurity in most iron salts and there is little doubt but that the results of the Rowett Institute experiments are attributable to traces of cobalt in the iron oxide used. Filmer and Underwood (1937) showed that in Australia 0.5 mg. of cobalt daily is necessary to cure badly affected cows, 0.1 mg. being sufficient for sheep. Our own experience has been that the addition of 4 ounces of a cobalt salt (sulphate, or nitrate, 25 per cent less of chloride) to a lick consisting of 100 lb. of bonemeal and 50 lb. of salt is sufficient at the start and that once the cattle or sheep begin to improve the quantity can be reduced to two ounces.

Alternatively the cobalt salt can be given in drinking water. At first one grain of sulphate or nitrate should be dissolved in 200 gallons of water, the quantity being reduced to half for routine prophylactic use. Individual cases may be dosed by preparing a solution of one small teaspoonful of the cobalt salt in a pint

of water and administering a daily dose of one tablespoonful of the solution.

Osteodystrophia Fibrosa.—In no part of Kenya is the lime/prosphoric acid ratio of natural grazing so unbalanced that bone diseases are produced by pasture. The Colony is fortunate also in that no marked deficiency of these important minerals occurs. Trouble frequently arises, however, from the unbalanced mineral composition of maize and bran, typical samples of which gave the following figures:—

	CaO	P_2O_5	Ratio
	Per cent	*Per cent*	
Maize	0·01	0·51	1: 51
Bran	0·15	2·39	1: 15·7

The lime/phosphoric acid ratio of normal bone is about 1.5 to 1, hence the danger of feeding maize and bran to horses is readily appreciated. Experience has shown that rations with a ratio wider than 1:5 are liable to cause trouble, although the actual figure depends on the absolute amount of lime in the ration, and for safety it is better to aim at a ratio of 1:2.

The disease produced in horses is known as "big-head" and "millers' disease". It is characterized by deformation of the bones of the head and erosions of the surfaces of the bones in the joints. The bones of the skull and lower jaw are soft and thickened, and a test for the presence of the disease, which consists in determining the ease with which a stylet can be driven into the bones of the face, has been devised The bones of the limbs become unusually liable to fracture and the ligaments are easily torn from their attachments. Swelling of the hard palate may reduce the diameter of the nasal cavity and lead to snoring.

To counteract the excessive phosphoric acid, ground limestone may be added to the concentrate ration, the amount to be added being dependent upon the ration. Lucerne, with a ratio varying from 2:1 to 7:1 and rich in lime, will, of course, assist in correcting the adverse ratios of maize and bran. When lucerne is not fed, about half-a-pound of good limestone should be added to every 100 lb. of maize and 2 lb. to every 100 lb. of bran to give a ratio of 1:2.

Anaemia in Sucking Pigs.—When housed in sties with impermeable floors, sucking piglets often develop a form of anaemia which can be counteracted by giving them a mixture of iron and copper salts. The simplest way to do this is to prepare a mixture of—

Copper sulphate	12·5 grammes
Iron sulphate	100·0 grammes
Water	500 cc.
Molasses	500 cc.

The teats of the sow should be painted with the mixture daily.

Salt Deficiency in Camels.—Camels (and other animals) in hot dry areas require an abundance of salt in order to permit of sweating, a procedure necessary to regulate the body temperature. Peck (1939) has shown that the disease of camels known as "Dalehan" in British Somaliland is preventable by permitting free access to salt. His experiments show that a camel's requirements average about 4½ oz. of salt a day, although if permitted to take as much as they wish considerably more will be taken after drinking on watering days and less on other days.

The condition known as cutaneous necrosis is characterized by local, painful swelling of the skin. The hair over the area soon falls out and the skin in the centre becomes hard and dry like a "sitfast". After a week or two the dead piece of skin at the centre becomes demarcated from the surrounding lining tissue and, if squeezed, pus will usually appear somewhere along the line of separation. Eventually the centre sloughs away, but instead of healing the edges of the wound often become under-run with pus like a "veld-sore", and the lesion gradually becomes larger. Local lymphatic glands become swollen and painful. Lesions may appear at any point on the skin, and in addition the animal appears generally off-colour. It lacks vigour, has a dry, dull coat, is constipated and, in the females, milk yield is reduced. Any accidental wounds are difficult to heal.

Peck has also shown that the provision of a full salt supplement has a remarkable effect on the prevention of an arthritis of camels known in Somaliland as "Gudan".

Rickets and Sweating Sickness are discussed under vitamin deficiencies.

VITAMIN DEFICIENCIES

Although the number of accessory food factors proved necessary for health increases year by year, the majority of the newer factors are of theoretical rather than practical interest since they are present in most normal rations. Care has also to be taken in applying the results of research carried out on rats or

pigeons, the animals most frequently employed for laboratory experiments, to the feeding of domesticated stock. Vitamin E, which has to be present to ensure fertility in rats, has been shown by Underbjerg (1940) to be quite unnecessary for goats and it is very doubtful indeed if it is of any significance at all for species other than rates and poultry.

For domesticated stock, vitamins A, some of the B complex, D and K are the more important.

Vitamin A is a fat-soluble compound related to and derived from carotene. (The substance which gives the orange colour to carrots is a carotene.) The richest sources of preformed vitamin A are the fish-liver oils; but animals are able to use carotenes equally well. Hence lucerne, carrots, red-palm oil, ensilage, etc., are the more important from the stock aspect. Vitamin A was originally known as the anti-xerophthalmia factor; but it is now known to have many functions. It has often been referred to as the anti-infective factor, for in early, and in mild, human vitamin-A deficiency in children increased susceptibility to infections of the skin and mucous membranes occurs. Lack of vitamin A also causes night-blindness in man.

In stock there is little doubt that shortage of vitamin A is an important factor in outbreaks of white scour in calves. Lack of it is the direct cause of a form of roup in poultry and there is a distinct possibility that the vitamin may have some connexion with some outbreaks of ophthalmia that occur in cattle and sheep during dry seasons.

Colostrum contains a much greater quantity of vitamin A than milk, the colostrum of heifers being richer than that of cows (Dann, 1933). The vitamin A and carotene content of milk depends to a great extent on the food of the cow; but the colostrum content varies from cow to cow in a manner which is not fully understood.

It has been shown by Stewart and McCallum (1938) that white scour and joint-ill are significantly more prevalent in the calves of cows whose colostrum vitamin A value is below a certain figure. The addition of a source of vitamin A or carotene to the feed of very young calves is therefore indicated, particularly when grazing is dry and cows are unlikely to be receiving liberal supplements in their food.

The rearing of calves on separated milk, to which cod-liver oil (or a vitaminized oil) and yeast have been added, is based on the necessity for supplying such animals with ample vitamin A and the B-complex. The usual procedure is to add one tablespoonful of oil to one gallon of separated milk. In America addition of yeast is not now considered worth the extra expense; but on farms where sweating sickness occurs a tablespoonful of dried brewers' yeast to the gallon is worthy of trial as a preventive.

In chickens lack of vitamin A causes a very well-defined syndrome called "nutritional roup". In the early stages there is catarrh of the eyes and nose, the discharge being water-clear and mucilaginous, but containing whitish flakes of material. There is a tendency for the eyelids to cohere. The birds appear rather lifeless and pale in the comb, but eat well. Later cheesy masses of material are found in the nose, mouth and quite often under the eyelids. There is some obstruction of the air-passages which leads to rattling breathing, and as the bird lacks interest in its food condition is lost. Gasping for air often occurs before death.

The condition can usually be diagnosed with certainty after death for the majority of cases show raised whitish spots, somewhat larger than a pin-head, in the pharynx and oesophagus. These spots are the result of blockage of the openings of the mucous glands since the secretion of mucus continues for a time after the orifice is occluded.

Vitamin A deficiency in poultry is easily prevented by supplying ample green food. Lucerne is the greenstuff of choice.

Vitamin B was originally the vitamin, lack of which caused polyneuritis in pigeons. This vitamin is now known as B1, and since it has been synthesized as thiamin. It is not of practical significance to the stock-farmer since it is present in the seed coats of the majority of cereal grains and, at least in adult animals, a deficiency can only arise when a highly polished grain such as polished rice is fed. Bran and rice dust must obviously be rich in it.

It is not many years since it was realized that vitamin B consisted of more than one essential factor. To-day there are a number recognized; but most of them have been identified chemically, synthesized and hence are related to the B-complex only historically. In so far as stock are concerned they are not of great importance since many are made by the bacteria of the rumen and others are

present in ample quantity in all but the most outrageously artificial of diets.

It is convenient here, however, to mention two diseases in which we have some evidence that a factor possibly connected with the B group is involved. These conditions are sweating sickness of calves and intestinal emphysema of swine.

Sweating sickness of calves has already been described in No. XII of this series of "Notes on Animal Diseases". It has not been found possible to reproduce this disease at the laboratory, attempts to feed calves on unnatural diets deficient in the B complex other than B1 having been frustrated by digestive disturbances, and experiments have, therefore, been restricted to efforts to cure a few natural cases of the disease which have been sent in by farmers. It has been found, however, that both yeast and a crude liver extract appear to possess a marked curative action. Liver extract prepared at the laboratory has also given good results in the treatment of early cases on certain farms.

On one farm in the Rift Valley, however, the administration of small doses of iron sulphate and copper sulphate appears to have given better results than liver extract, although reports from other districts suggest that the inorganic salts are there of no value. It is, of course, possible that the name "sweating sickness" covers more than the one disease entity and further work on this condition is desirable.

Intestinal emphysema of swine is a peculiar condition only discoverable on post-mortem examination. It occurs in pigs which have made good gains in weight during the feeding period and natural cases have been reported in both Kenya Colony and Tanganyika Territory.

The disease is characterized by the occurrence of what are best described as "bubbles of gas", often in bunches, along the small intestine at its junction with the mesentery or skirt. Biester, Eveleth and Yamashiro (1936) produced the disease experimentally in America by feeding pigs on rations consisting of polished rice, a protein supplement, cod-liver oil to supply vitamins A and D, and a mineral mixture. Piercy at Kabete has confirmed these experiments and a paper on the subject is in course of preparation. In view of the fact that yeast added to the ration reduces the incidence of the condition, it is possible that one of the B-complex factors is involved.

Nicotinic acid, lack of which produces black-tongue of dogs, is necessary for pigs, and when it is not present in the diet a condition known as "pig pellagra" results. This condition is, however, of theoretical rather than practical significance.

Vitamin D is the antirachitic vitamin. Rickets can occur in foals, calves, lambs and piglets; but is not common in any of these species. The production of rickets is a complicated process in which vitamin D, sunlight and the mineral constituents of bone all play their part. No doubt the tropical sun assists in reducing the incidence of this condition in East Africa even below that of temperate climes. The most potent sources of vitamin D are the fish-liver oils.

Vitamin K is the antihaemorrhagic factor, and although it is now being used in human medicine in controlling conditions in which there is a tendency to uncontrollable bleeding, its importance to other animals has been studied mainly in chickens.

Lack of vitamin K causes anaemia and the occurrence of large haemorrhages under the skin and between the muscles. The blood clots much more slowly than the blood of normal birds. The factor is present in most green plants, lucerne and cabbage leaves being excellent sources. The absorption of the factor from the intestinal canal is dependent on the presence of bile, and symptoms of vitamin K deficiency develop if the bile duct is tied, even when the bird is receiving ample supplies of vitamin.

Cases of vitamin K deficiency have not been diagnosed in East Africa, but in view of the fact that poultry sometimes go short of green feed during periods of drought, there is always the possibility that they may be encountered.

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LONG-TERM AND SHORT-TERM CASSAVAS

Department of Agriculture,
Kawanda,
P. O. Box 265,
Kampala,
6th November, 1943.

The Editor, East African Agricultural Journal

Dear Sir,

It has been suggested here that correspondents to your journal might be able to throw light on a curious disparity in the practice of cassava cultivation between the various East African territories.

In those parts of Uganda where cassava is an important reserve against famine it is the custom to plant up the greater part of the acreage with so-called "long-term" varieties. This description is perhaps not sufficiently definitive, but by it is meant varieties which stay in the ground for two or more years without appreciable deterioration to the tubers. The advantages of this course are presumably—

(*a*) a sense of security in that there is always something in the ground (neglecting the ravages of mosaic);

(*b*) an insurance against bad seasons in that cassava once established is relatively indifferent to ordinary periods of drought.

According to my information some other territories prefer "short-term" or quick maturing varieties, and unhesitatingly discard the others from their trials.

Very probably there is some entirely rational agricultural or economic reason for this, but it might be most interesting to have on record an explicit statement of the reason for this disparity.

Yours faithfully,

J. D. JAMESON,
Senior Botanist.

Comment by the Department of Agriculture, Kenya

In most areas in Kenya there is no doubt that the "short-term" cassava is more popular than the varieties which have a long growing period. There is also no doubt however that there is room for "long-term" varieties. The probable reason for the emphasis on "short-term" has no doubt been because cassava itself does not come into prominence as a food crop except in difficult times when there is urgent necessity for being assured of a food supply in seven to eight months, whilst varieties taking longer are naturally not so popular. These "long-term" varieties are also very apt to be neglected with regard to cultivation and, if seasons are good, to be allowed to disappear altogether in long grass. There is a considerable amount of work to be done on cassava varieties in Kenya and it is only lack of staff which has prevented more detailed experimental work being carried out.

C. OATES,
for Acting Director of Agriculture.

Comment by the Department of Agriculture, Zanzibar

So far as the Department of Agriculture is concerned, as a general rule, we harvest our cassava trials after twelve months in the field. This period gives us a happy combination of yield and quality. Cultivators will harvest earlier than twelve months in many instances sacrificing some yield to security. I believe the prevalence of theft is responsible for a considerable amount of early harvesting.

Secondly, there is no normal planting of a "famine reserve" plot by the local cultivator. He plants cassava to eat as a staple and he wants it in good condition.

So far as is known there are no cassava varieties here which are really good eating fresh after some fifteen months. The floury texture goes and the roots become rather woody.

The varieties Msitu and Mbega can be left in the land for a couple of years without changing colour and rotting as do many other varieties but the texture of the roots deteriorates and they are only suitable for use in the preparation of dried cassava.

J. C. MUIR,
Director of Agriculture.

Comment by the Department of Agriculture, Tanganyika Territory

(i) In Tanganyika both types are desirable. The quicker maturing kinds are often treated as an annual crop, whereas that is not possible with the long-term varieties except at some sacrifice in yield.

(ii) A second consideration is the use to which the root is put. For consumption fresh the younger the root the better, and hence quick maturers are usually popular for eating raw. For the making of cassava flour, bulk is the important thing. Flavour and fibre content matter little. Here the types which give a heavy crop, albeit not for two or three years, come into their own.

(iii) The point of view of the Department is well put by the Senior Agricultural Officer, Lake Province, who writes:—

"Where cassava is popular and regularly used as a foodstuff, the long-term varieties form a lock-up of food and, so far as my experience goes, are normally the most popular types; for instance near Kigoma, and in Uzinza. Regular plantings maintain a steady area of matured cassava roots, and a flush of other foods, such as grains in an exceptional year, results only in the lock-up of food in the form of cassava roots being increased, probably to be disposed of when prices elsewhere make their sale attractive.

Departmental interest in cassava lies, however, less in these areas where it is so well established, as in the other areas which rely primarily on grain, and where, while a constant attempt is made to maintain a minimum acreage under cassava, real drives are made for the most part only when grain shortage, or locust invasion, makes the need of cassava urgent (perhaps desperately so). When a grain shortage is envisaged, sweet potatoes are the obvious first line of action, and can be expected to yield a crop shortly after the harvest of the subnormal grain crops. An unfortunate time in many respects, for this potato harvest appears just at the time when the grain is being brought into the houses, and when food supplies appear most abundant. The potatoes tend to give a false sense of security and probably for a week or two encourage a rather wasteful use of food: however, they serve a useful purpose especially among those who have suffered most severe grain losses.

The next period, that between these harvests of grain and emergency-planted sweet potatoes and the planting of next season's crops can usually be covered by the meagre supplies of the previous season's cassava (reserve); so that the real pinch is not felt after the seeding of the subsequent year's crops, and before their maturity. The last quarter of such a year can be helped out by a second planting of sweet potatoes, but the first three months after sowing may be a critical period, i.e. in Sukumaland late December to mid March.

It is to cover this period that the quick maturing cassavas are required; this is perhaps best illustrated by the following (imaginary) calendar.

Agricultural calendar approximately illustrating need for short-term cassava varieties in areas where cassava is grown only as an emergency crop, and not as a regular food crop.

Nov.-Dec.: Normal grain sowings.

Dec.-Jan.

Jan.-Feb.: Grain harvests estimated to be subnormal.

Feb.-Mar.: Drive for (*a*) increased sweet potatoes.

Mar.-Apr.: Drive for (*b*) increased cassava to meet emergency.

Apr.-May

May June: Sub-normal grain harvests.

June July: Harvest of emergency sweet potatoes begins.

July August: Harvest of emergency sweet potatoes continues.

Aug. Sept.: Use of old cassava reserves begins.

Sept. Oct.: Use of old cassava reserves continues.

Oct. Nov.: Use of old cassava reserves ends.

Nov. Dec.: Normal grain sowings: and drive for 2nd planting of sweet potatoes.

Dec. Jan.

Jan. Feb., Feb. Mar: Critical period of food supplies without short-term cassava.

Mar. April: Harvest of 2nd planting sweet potatoes commences.

Apr. May.

May June: Maturity of normal grain harvests.

June July, July Aug., Aug. Sept.: Food supplies once again normal (? with luck).

Sept. Oct.: Maturity of long-term cassava.

T. B. ALLNUTT,
for Acting Director of Agricultural Production.

Comments by the Scientific Assistant in charge of cassava investigations at Amani

The inquiry made by Mr. Jameson at once raises several other questions, mostly of a physiological nature, which we are not able to answer at present.

The replies from departments answer, in part, his query but to my mind they tend to reflect departmental policy and the efforts to influence native agriculture rather than going to the root of the matter and elucidating the fundamental reasons for the prevalence in some districts of early varieties and in others of late varieties.

In my opinion the situation has arisen by chance through environment aided by unconscious selection. It has been my experience that the African, in the course of ordinary cultural practices, will never wilfully destroy an adventitious food plant of any kind which happens to spring up in his shamba. In this way a self-set seedling grows to maturity and in due course is harvested and eaten. Should such a plant show particular merit as compared with varieties already in cultivation it will be propagated and eventually displace the local favourite. In an area habitually accustomed to more or less frequent famine periods any cassava seedling arising in this way (and there must be many thousands self-set annually) which showed a marked tendency towards the "long-term" category coupled with other desirable qualities would be prized and would inevitably come into general cultivation.

In localities unaccustomed to the ravages of frequent famines such varieties would be overlooked or in fact may even be discarded in favour of earlier-maturing varieties. In such areas other forms of starch foods, e.g. maize and rice, figure in the diet and the necessity for a root crop such as cassava is less pressing. Here cassava is planted to tide over a relatively short annual dry period or to assure a supply of food when the annuals fail. Selection in this case is in favour of quick-maturing varieties—long-term varieties being undesirable because the land is wanted for annual crops as soon as cultivation can be resumed.

In brief, protracted and frequent droughts and famines lead by dire necessity to the cultivation of long-term varieties, favourable climatic conditions and "easy living" to short-term varieties.

Turning now to the scientific implications of cassava cultivation which have a direct bearing on the breeding of new varieties. The breeding programme was started in response to the demand for disease-resistant varieties. The demand has now been extended to include, in addition to disease-resistance, long- and short-term, bitter and sweet, varieties.

Some of the questions which immediately come to mind are firstly, "What are long- and short-term varieties?" A somewhat loose and generally accepted definition is, for the former those varieties which take longer to mature, which are capable of remaining in the ground and retaining their edible qualities for protracted periods; and for the latter, quick-maturing varieties. The next question is, "When is a cassava plant mature?" I can find no universally satisfactory answer. Flowering and seed setting is by no means a sure guide. Does natural leaf-fall indicate maturation? If so, do long-term varieties hold their leaves even under the adverse conditions of prolonged drought? the answer, presumably, is no.

Some varieties which were planted four years ago in the maintenance plot were recently dug up. In some the tubers were sound and the African assistant pronounced them to be of good quality. Others had a tendency to be sugary—indicating that the plant was drawing on its reserves. Such tubers are not valued as food by the cultivator and are, of course, useless for making flour. In yet other varieties (presumably of the short-term category) the starch had disappeared completely and where decay had not supervened nothing but a "spongy" shell remained. The amount of foliage varied from almost leafless sticks to a moderate crop of leaves.

From first principles these field observations suggest that, like any other plant, cassava endeavours to adjust itself to environment. When conditions are adverse and metabolism at a minimum the starch reserves are drawn upon. The inherent capacity of a variety to recuperate after one or more adverse periods resulting in the resumption of starch formation may possibly determine whether it is a long-term variety, failure to do so placing it in the short-term category.

The answers to all these questions can be supplied only by properly conducted field experiments coupled with the necessary laboratory work and carried out in various localities under as wide a range of conditions as possible.

R. F. W. NICHOLS,
Scientific Assistant.

REVIEWS

FARM TREES AND HEDGES

A bulletin of some 200 pages, under the above title, by Dr. J. S. Yeates, of the Massey Agricultural College, published in New Zealand in 1942, appears to be a model of what such a publication should be.

It is a mine of information about the trees and shrubs which have been, or can be, used in New Zealand for the various purposes required on a farm. A most valuable feature is a large number of excellently produced photographs showing the habit of the various species and examples of their successful use for particular purposes. There are photographs of botanical details to assist identification where necessary, particularly of the useful native species and also instructive pictures showing mistakes which have been made in choice of species or in subsequent treatment.

This practical information regarding species cannot unfortunately be made use of in East Africa, except for a few very adaptable trees such as Macrocarpa Cypress and *Eucalyptus globulus*. New Zealand is a long way south of the Equator and has well marked summer and winter seasons. Trees that are used to those conditions do not flourish in the perpetual temperate summer climate of our Highlands and particularly because where we do get night frosts these occur in the same period as the hottest day temperatures of the year. Actually in many districts there is a hot season with frosts in January and a cold season with lesser frosts in July, with two intermediate rainy growing seasons, so that it is not surprising that, though the climate is definitely temperate, trees from the temperate regions do not like it.

In addition, however, to its recommendations and descriptions of particular species, the bulletin has some general chapters on tree planting which are of much wider applications. It starts with a chapter on the reasons for the planting of trees and hedges, and tree planting is not so universally adopted in East Africa that they will not bear repetition. The main ones, equally or even more applicable here, are:—

Protection of crops and stock from wind.—This is certainly one of the most important, but as the benefits are often not clearly obvious many farmers will not go to the trouble of planting efficient windbreaks. Those which have been planted in East Africa are usually so sketchy or incomplete through bad management or neglect that it is not surprising the results are not impressive. In New Zealand it is shelter from the cold that is most needed, but in East Africa protection from the desiccating effect of the wind is more important. The bulletin quotes experimental evidence from several countries to show the beneficial effect of shelter from both aspects.*

Production of timber and fuel for farm purposes.—This is so obvious as to need no discussion, but it is astonishing how many farmers make no attempt to provide a wood lot. They are content year after year to send long distances for these requirements or put up with the scrappiest of material.

Protection of stock from sun.—Shade from the hot midday sun must be beneficial, but it is rarely that one sees any systematic attempt to provide it. It is often not easy to find the suitable tree for the conditions, and the trees require cultivation and complete protection from the stock till they reach a good size. But undoubtedly it is worth while.

Prevention of erosion.—By planting up with trees, steep land on farms can be put to economic use which could not be used for grazing or agriculture without danger of erosion. Land already eroded can also be put under trees and rejuvenated in the course of time.

Not least among the many other benefits of tree planting is the beautification of the farm.

The next chapter is on planning the general layout. Much greater thought should be given to this than is generally done. Few farmers have the opportunity to plan the tree-planting of their farms at one time as a whole, but whenever they decide to plant some trees, either for a particular purpose or because they happen to have a little money to spare, the results will be so much more satisfactory if careful thought is given to the layout. How many copses planted for shelter or fuel supply have been made too near the house and became a nuisance because they keep the morning sun off or a perpetual menace through possibility of danger to the house by windfall. How many avenues keep the roadway perpetually muddy or have constantly to be hacked about to keep it open because people will not think out the eventual size of the tree and plant far enough back in the first instance.

Tree planting round the homestead certainly repays careful planning, and the author pleads for a layout which makes it part of the general farm shelter. He suggests that an area of 10 or

* *See* also the article by G. H. Warren in this Journal, Vol. VII, No. 1, pp. 8-19, July, 1941.—*Ed.*

20 acres should be enclosed by a really good shelter belt on three sides. Inside, where the climate is quite different from that outside, would be the house and garden, farm buildings, orchard, piggery, calf paddock and warm "home paddocks" for other stock. On the outside there will also be shelter on one or other side of the enclosed area according to the way the wind happens to be blowing. He deplores the fact that "a new generation has grown up to whom farming is a business pure and simple and a business to which the value of a well sheltered homestead has not been proved in terms of pounds, shillings and pence". There are many delightful farm homes in East Africa more or less on the author's model, but there are many in terrible contrast, which can hardly be described as "homes" at all. The other extreme of an elaborate expensive layout to the homestead at the expense of the development of the farm is to be deprecated, but undoubtedly a comfortably sheltered homestead, practically planned to serve farm purposes, also is a genuine asset and a help to greater efficiency on the farm.

Much space is given to the planning of shelter-belts or windbreaks on the farm and much interesting information is given, particularly from work in the U.S.A., Russia and Denmark, where actual measurements of the results of various kinds of belts have been made. It appears that there is a reduction of wind force up to a distance of 40 times the height of the belt on the leeward side. Curiously enough the average amount of the reduction is rather greater if the belt is slightly penetrable to wind in its lower part. However, if the belt is completely impenetrable the wind is also slowed up on the windward side for a distance up to 15 times the height, and it would seem that this type of shelter-belt should be aimed at, though difficult to attain.

It is stated that experiments show the wind reduction is only great enough to benefit crops up to a distance of about 10 times the height of the belt and therefore, to provide the most complete shelter, belts should not be further apart than 12 or 15 times their height. Shelter-belts must be as nearly as possible at right-angles to the prevailing wind, and a point that is brought out is the necessity for them to be as long as possible. This is because the wind always veers somewhat, so that the area permanently sheltered behind the belt is triangular. It is also found that there are areas at the ends where the wind-force is actually increased by the belt, i.e. it has created draughts, and the longer the belt the smaller the proportion of land so affected. For this reason also it is important that the belt should have as few gaps as possible, such as gates.

There follows a chapter on the making of shelter belts. I have not space for detail in this article, but will quote a few of the salient points as a guide to farmers. It is essential to have dense growth near the ground, otherwise half the value is lost and one may even create undesirable draughts. Few tall-growing trees will retain dense branch growth in their lower parts, and if one such suitable to the conditions cannot be found, then the tall trees must be supplemented by a row of a more bushy short tree or shrub. In districts suitable to Macrocarpa or Lusitanica cypress a single row of these trees may prove effective and will save space. To get additional shelter by extra height they may be supplemented by a row of *Eucalyptus saligna* or *globulus* planted at least 20 ft. from the cypress row.

In drier districts in East Africa one would probably have to rely on a row or two of the drought-hardier gums supplemented by hedges of hardier shrubs or small trees, such as Kei apple, Carissa, Mysore thorn, *Euphorbia tirucalli*, etc.

A mixed shelter-belt of three rows and hedge is usually the best because it gives scope for using species of different characteristics and so obtaining a belt of greater efficiency. It also provides a variety of foliage tints, permits the introduction of a few flowering trees, and so makes the shelter-belt a thing of beauty as well as utility. A point which is particularly stressed is that it is no use being niggardly with the land if a good windbreak of several rows is to be established. For good shelter the trees of shrubs need all the branches they can grow and therefore must not be overcrowded so as to cause lower branches to be smothered.

There is a useful chapter with some most instructive photographs on common mistakes in growing shelter trees. Throughout the bulletin it is taken as axiomatic that all tree plantings will be fenced, and it appears to be a normal practice with the New Zealand farmer. In East Africa it is unfortunately otherwise. Farmers who will spend a lot of trouble and money on tree planting, regularly let the results be partially or entirely ruined because they will not go to the additional expense of a good fence. They may say they cannot afford the fence, but if so it is stupid to waste their money on the tree planting. This

particularly applies to shelter-tree planting. If a fuel plantation is damaged through lack of a fence it will still provide some firewood, though possibly only half what it should have done; but a shelter-belt must be well grown, complete and permanent, to be effective and to justify the expenditure.

The bulletin emphasizes strongly the dangers of creating draughts and the necessity to prevent this by ensuring dense bottom shelter. This must be done by having the fence well away from the trees, so that the lower branches can spread and not be damaged by stock, and by planting the trees sufficiently wide apart, so that as they mature the lower branches would not be smothered.

This wide planting means that it will be some years before the trees close up and become effective as a windbreak. It is suggested this can be remedied to some extent by planting nurse trees in a row or interspersed, provided the farmer will keep an eye on them and cut them out as soon as they begin to interfere with the permanent trees. If finally the taller growing trees are of kinds that will not keep a sense growth of lower branches, then they must be supplemented by a hedge of dense-growing shrubs sufficiently far from the tree row that it will not grow spindly from the shade of the latter or itself interfere unduly with the lower branches of the trees. The distance will have to be at least 15 to 20 ft.

Further chapters of the bulletin contain much practical advice on the actual planting of trees and hedges, on the after-care of plantations, on the trimming of trees, and points to be considered in selecting trees for various soils and situations. Finally there is a detailed description of the various species of trees and shrubs which have been found useful for planting in New Zealand and the particular purposes for which they are suitable.

It is to be hoped that it will be possible in the not too distant future to compile a similar guide-book to tree planting for East Africa. It has to be remembered, however, that our experience here is several generations shorter than that of New Zealand, that we have a far greater range of climate and soil to cope with, and that in areas where tree shelter is most needed the conditions for tree growth are far more difficult than in New Zealand.

In conclusion I would draw attention to the following paragraph from the preface to the bulletin: "It had been hoped that certain experimental work could be carried out in time to include in this publication some actual figures showing the effects of shelter on yield from New Zealand's main crop—namely pasture". This work was not carried out owing to the expense, but it is most sincerely to be hoped that it will be undertaken at the very earliest opportunity. The few figures which have been arrived at in certain countries are favourable to tree planting, but they are very few and far between as yet, and badly need reinforcing from other sources and for a variety of conditions. Reliable figures of actual results will be the most convincing argument to the farmer.

H.M.G.

THE SOILS, VEGETATION AND AGRICULTURE OF NORTH-EASTERN RHODESIA: By C. G. Trapnell. Report of the Ecological Survey; Lusaka, Government Printer, 1943.

This long-awaited continuation of Mr. Trapnell's similar report on North-Western Rhodesia has at last appeared, and although the print is objectionably small and the margins are an ugly succumbing to paper shortage, one must be grateful to the Northern Rhodesia Government for having published this very important but somewhat bulky document in these days of stress and strain. It is packed with information based on painstaking and detailed research which will prove invaluable alike to the general student of human geography, to the specialist agriculturist and, above all, to him who, with me, identifies the often misused term "Colonial Development" with "Planned Improvement of Native Land Use". It is to be greatly regretted that publication of the vegetation map—presumably a worthy successor of that of North-Western Rhodesia published in 1937—had to be postponed.

Part 1 deals with the natural conditions and takes up one-quarter of the report. A concise, but clear, introduction provides a useful summary of the country's physiography and climate. This is followed by a lengthy exposition on regional soil types from which one gathers that the author attaches considerable importance to the existence, in Northern Rhodesia, of a climatic sequence of soil types; probably a very sound suggestion where we have to deal with so vast an expanse of undoubtedly very old land forms. In the next chapter on "Vegetation and soils", Trapnell expounds a number of very interesting interrelations between vegetation and soil, and vegetation and soil fertility which, as he admits, "offer a considerable field for further investigation"; pending this, however, it seems quite permissible to adopt his proposed land classification based on the "vegetation—soil

unit, i.e. a land unit uniform both in soil and vegetation type". (Paragraph 40.) Then follows a classification of vegetation types which, to me at least, looks reasonably simple and sufficient at the present stage of our knowledge. His Chipya Types (paragraphs 58-69) are of particular interest to those in East Africa who have to grapple with the problems of vegetations marginal between evergreen forest and Brachystegia woodland.

All this automatically leads to a preliminary consideration of the Land Resources in which due acknowledgment is given to the late Mr. G. Milne's valuable help. After a short review of the potentialities for extended European settlement, rightly emphasizing the limiting factors of "a somewhat problematical nature of the climate and the widespread poverty of soil" (paragraph 77), native land utilization is dealt with in a manner introductory to the main theme of the report, and resulting in a commentary on the existing land types based on the vegetation–soil unit and on five simple utilization categories: Useless, Partial Cultivation, Shifting Cultivation, Re-cultivation and Semi-permanent or Permanent Occupation.

Part II, the longest, comprising fully two-fifths of the volume, is a most valuable and detailed account of the existing native agricultural systems (including an interesting attempt to decipher their evolutional history), such as one longs to see compiled for all the other East African dependencies. It is, of course, impossible to do justice in a short review to a chapter so full of vital facts and far-reaching suggestions. All the reviewer can do is to press everyone concerned with East African native life and its betterment to study it most carefully.

The same remarks must be applied to Part III, Agricultural Development, covering one-third of the report of which, quite naturally, it forms the crux and keystone. With its two sub-divisions, Conservation and Improvement, it deals fearlessly with those East African cankers, deforestation, soil deterioration and erosion, and overpopulation, and with their remedies: realization of carrying capacity, controlled settlement, and land and forest protection. Courageous emphasis is put on the fact that the proposals for improvements are, and must be, "rather a commentary on needs and possibilities observed than definite recommendations", and on the inevitable need for "experiments necessary before their effectiveness can be determined" (paragraph 337). These latter are particuarly called for with regard to the application of grass manure, as yet by no means fully understood but very promising and frequently advocated also elsewhere in East Africa; and to the amelioration of "dambo soils"—the equivalent to our "mbugas"—to which Milne has drawn so inspiring attention in his latest writings, and on which I have been preaching for some time with equal fervour. For there is no denying Nature's dictate that, in semi-arid countries, Man, who inevitably exhausts the ridge- and slope-soils, must sooner or later descend with his agriculture to the "bottom-lands", and in doing so must adapt his agricultural methods to the new sets of environmental conditions he encounters.

In the Conclusions a large-scale development centred on the four specialized regions of the former Tanganyika Estate, the Fort Jameson and Petauke North Charterland area, the surroundings of Lake Bangweulu and the Serenje and Mkushi high ground, is advocated in preference to "coping with scattered local problems" (paragraph 431). It all sounds very plausible; to decide, however, whether or not this is the right way of attack I must leave to more competent minds and to a much more intimate knowledge of local conditions than I can claim to possess. There are three useful appendices: a regional summary in index form; a list of native crop names; and one of native names for trees and grasses.

Northern Rhodesia must, indeed, be called fortunate in possessing the will and insight, the money and, last not least, in Mr. Trapnell a brilliant and enthusiastic research worker of the right type, to provide itself with those ecological fundamentals without which any talk or action about "development" of African native communities is, at its best, pious and sterile lip-service, or, at its worst, disastrous guess-work and blundering. The next step in the right direction must be the institution of an equally efficient soil survey for which this ecological report constantly, urgently and rightly presses. Is it too much to hope that this ray of promising enlightment, pointing towards reasoned planning and radiating from our southern neighbour, may before it is too late penetrate into the other East African dependencies which, to a very large and dangerous degree, are still hibernating in the old-fashioned unscientific atmosphere of mere opportunist, hand-to-mouth and day-to-day exploitation of their physical and organic resources? One hopes and very much wonders——

C.G.

SLEEPING-SICKNESS RESETTLEMENT IN NIGERIA: "The Anchau Settlement Scheme", by T. A. M. Nash, *Farm and Forest*, 1941, Vol. II, No. 2, p. 76.

The author describes in detail the re-settlement of the population of Anchau District, Nigeria, as a preventive measure against Sleeping Sickness (*T. gambiense*). The species of tsetse fly present is not mentioned, but it appears to have been *G. palpalis*.

A medical survey of the area showed that one-third of the population had Sleeping Sickness, while in some hamlets as many as 50 per cent of the people were infected. The population was so scattered that anti-tsetse measures were impracticable; but the author found that by re-settling the people a series of district settlements could be made, embracing Ikara, Anchau and Kudaru Districts, which settlements could be linked together to form a fly-free corridor extending from the main Zaria–Kano line to the Bauchi Light Railway.

The scheme was financed by a grant from the Colonial Development Fund, on the understanding that economic development must be an essential part of the scheme.

As a first step, 712 square miles of practically unmapped country were surveyed and mapped (on a scale of 1 in. to one mile) to find the distribution of the population and the streams. It was found that there was roughly one linear mile of stream to each square mile of country. The area to be re-settled was a corridor about 70 miles long with an average width of 10 miles.

A completely new census of the population was necessary to provide the accurate figures for such a large-scale move. The aim was to provide a density of population of at least 70 to the square mile, which was considered the minimum required to keep down the re-growth on the cleared streams. In the northern part of the corridor there were 50,000 people, but only 4,300 were required to move.

An agricultural survey of some long-established villages was made to determine how much land was required per head of population, and it was found that the amount of land actually under cultivation worked out at 2 to 2½ acres per head. Allowing for fallow and a slight increase in the size of the family, 4.3 acres per head was estimated for, or about 34 acres per family. (This means that the Nigerian family consists of eight persons, as opposed to 3.3 persons per family in many parts of Tanganyika Territory.

As local native opinion about the suitability of the land for agriculture was unreliable (or rather, the opinion expressed was not precise enough to be acted upon), an agricultural survey of the whole area had to be undertaken. Nash had observed that certain species of trees and shrubs were associated with certain environments, and had tenatively built up a series of plant indicators. His ideas as to the significance of certain vegetation communities were tested with trial plots of cotton and guinea corn in all the common communities; and by this means a very good idea was obtained of what types of bush were suitable for cultivation. Vegetational maps of the proposed settlement areas were then produced (on a scale of 3 in. to one mile), and from the final map the acreage of potentially good arable land was estimated and compared with the population to be settled. In all, 59,000 acres were surveyed by this means.

The population to be settled being known, as well as the acreage of good agricultural land available in the central thinly populated areas, the problem was "fitting in the people to be moved so that they would still live in the land controlled by their own village head. Failure to solve this jig-saw puzzle would naturally have upset the local Native Administration". This is the same problem as in Tanganyika Territory, where natives have, as far as possible, to be settled within their chiefdom boundaries. The Nigerian problem was solved in all but one or two cases, and in these the Emir arranged for slight adjustments in the inter-village boundaries.

The District Officer seconded to the scheme had meantime found out which hamlets were agreeable to combine to form new villages, and village sites were then selected by the people themselves. The sites had to be on well-drained ground, away from swamps, and were agreed upon provisionally, providing that trial shafts showed that sufficient water was available.

The original idea had been to lay out a series of 12-acre farms with 80-yard water-frontages, the farms to extend back for nearly half a mile up the slope, and the village was to be built on the high ground behind the heads of these parallel farms. The idea was that each householder would have 80 yards of stream slashing for which he would be responsible, his own grazing and a range of land suitable for any crop. The idea had to be abandoned soon after work started "as streams wind about, the land is seldom uniform, the size of the family may vary from 1 to 20, and the definite marking out of the farm might tend to make the householder consider that he *owned* the land". It was decided that elasticity

must be arrived at and that it would be far wiser to allow each village an excessive amount of land and leave the division of farmland to the hamlet head, and so adhere to native custom.

Prior to the move, and after the hamlet head had divided up the land, the people were informed that they must clear a portion of their new farms and open up the land with cotton in the ensuing rains. This ensured that they would have some land ready for guinea corn in the first wet season after the move. The actual move took place during the following dry season.

The building of the new villages was planned and supervised by the District Officer attached to the scheme. The commonest and best layout was to build the village around the open well space, 100 yd. spare, with a cement-lined well in the centre. Compounds were laid out singly or in blocks, depending upon the size of the family, the number of huts to the compound allowing an average of 2.1 people per hut, and each compound had its own pit latrine. The compounds were demarcated with live-pole fences of *Moringa pterygosperma.*

Round each well 30 yards square of *dhub* grass (*Cynodon dactylon*) was planted and demarcated with fig trees; only low crops could be grown in the village or within 30 yards of the backs of all compounds, and this outer ring was also demarcated by planting fig trees at intervals; pigeon pea was planted along the approaches to the village; and pawpaw seedlings (grown in a nursery), guava and mango seedlings were distributed. Each householder was given a budded orange tree.

During the rains the Control Officer and the Emir's representative paid house-to-house visits, explaining the simple facts of sanitation and other general propaganda. These propaganda tours were very successful, particularly amongst the women, who were showing signs of becoming "house-proud".

By an anti-rinderpest campaign, and the establishment of a clarified-butter unit, it was hoped to attract the migrant Fulani with their herds of cattle into the fly-free area, and to induce them to remain permanently. It was also proposed to start small herds of cattle in some of the villages.

Emphasis was laid on the production of compost and manure. There is a scarcity of live stock in the Anchau area, so female donkeys were issued to those members of the new villages who agreed to build a special donkey hut and conserve the manure in pits. The donkeys were not to be sold or hired out for the dry season. Special pits, 3 feet in diameter and 4–6 feet deep, were used into which the daily droppings of horse or donkey were thrown, covered with a layer of bedding and stamped down, with a little water added in the dry season. It was estimated that each donkey yielded nearly 1½ tons of manure yearly. The household sweepings, etc., were piled daily on a heap outside the front door; in the district market the sweepings were also piled in heaps and left to form compost; and following Hausa practice fire was occasionally put to the heaps, which charred the top few inches and helped to break down the tougher elements. The blood, paunch contents, etc., from the slaughter blocks were buried in trenches and covered with earth; a year later the manure was dug up, leaving a new trench ready for further use. Special emphasis was laid on the manure problem, as it was realized that unless a good zone of land round each village could be kept under permanent cultivation, the fallow period in the outlying fields would become so reduced that soil impoverishment would follow, and the villagers would desire to move elsewhere.

The Anchau settlement was not so thickly populated as to turn the country into endless farmland, but patches of bush remained between the villages as forest reserve. As the population increases, land can be reclaimed "after stream clearing". (This method of settlement is suitable against *G. palpalis,* but would not be effective against *G. morsitans.*) Two elementary schools, two Sleeping Sickness dispensaries and an animal clinic were built.

To maintain the corridor fly-free, the regrowth on the streams must be slashed once a year. This re-slashing must be continued into the barrier clearings, which extend a mile in length on the streams outside the corridor boundary, to prevent the reinfestation of the streams inside the corridor during the rains. The work was sub-divided into blocks, and groups of hamlets were responsible for the annual slashing of their own streams.

The author states that "Work started at Anchau with the arrival of a second Entomologist and a staff of Sleeping Sickness Control Officers, all of who had degrees or diplomas in agriculture". Two District Officers were seconded to the scheme, continuous help was provided by the Geological, Agricultural, Forest and Veterinary Departments, and a special Wells Officer sank most of the 64 wells. The results were that 477 square miles of country had been freed of tsetse fly by clearing 440 linear miles of stream at an average cost of £11 per mile, but no costs for the scheme as a whole are given.

H.F.

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